Solution Mining Research Institute Spring 2015 Technical Conference
Rochester, New York, USA, 27 – 28 April 2015

ABANDONMENT OF VERY DEEP BRINE-FILLED CAVERNS AT FRISIA SALT HARLINGEN

Antoine Duquesnoy, Well Engineering Partners, Hoogeveen, The Netherlands

Bertran de Lange, Frisia Zout B.V., Harlingen, The Netherlands

Abstract

To date, Frisia Zout BV, via ESCO part of the K+S Group in Germany, operates four brine caverns near Harlingen in the Northwest of the Netherlands at depths between 2400 and 3000 meters. The large salt creep in this depth range, caused by high pressures and temperature, has significant consequences with respect to the final abandonment of the brine-filled caverns. A particular geological feature in Harlingen is the presence of a carnallitic salt layer just above the Zechstein Stassfurt formation from which the halite salt is produced.

In 2004 cavern BAS-2 was shut-in for a long-term high-pressure test. Meanwhile five bleed-off and compression tests and two sonar measurements have been performed. A cavern rock mechanical model has been developed that describes the process of cavern convergence and brine permeation and migration into the surrounding salt rock as a result of brine warming-up and salt creep. The latest observation results are presented in this paper.

In 2010 Frisia has decided to definitely abandon cavern BAS-3 because of operational reasons and to sidetrack the well in order to develop a new cavern BAS-3-O some 500 m away from cavern BAS-3. In September 2014 cavern BAS-3 has been definitely abandoned. The closed-in brine volume of BAS-3 is far larger than the BAS-2 volume and an extra aspect is the hydraulic contact, presumably developed at the beginning of 2012, between the cavern brine and the overlying carnallitic salt layer. Carnallite preferentially dissolves in halite brine, meanwhile crystalizing the halite that precipitates. The brine conversion processes and their possible impact on cavern abandonment have been studied, both for delayed future contact in case of an intact cavern roof and for immediate direct contact in case of cavern roof breakthrough. Several model variants, inclusive hydraulic aspects, have been analyzed and a sensitivity and risk analysis has been performed. This paper presents the principal modeling and analysis results.

Key words: final cavern abandonment, salt creep, rock mechanical model, permeation and migration processes, brine conversion, precipitation, ‘dead’ volume, risk analysis.