Solution Mining Research Institute Fall 2019 Conference
Berlin, Germany, 23-24 September 2019

Sudden pressure drop in Nedmag cavern cluster

Abel Jan Smit, Jacob Visser, Ad Barth
Nedmag B.V., P.O. Box 241, 9640 AE Veendam, The Netherlands
Peter Fokker
Well Engineering Partners B.V., P.O. Box 612, 7900 AP Hoogeveen, The Netherlands

Abstract

Nedmag, a producer of inorganic chemicals, is located in Veendam, The Netherlands. A key raw material is $MgCl_2$, which is solution mined west of Veendam.
The $MgCl_2$ is found in two forms, bischofite and carnallite, of which nowadays only the bischofite is mined. The bischofite is selectively leached from the Zechstein III 1b layer, a mixture of salts containing about 15% bischofite. Apart from onsetting a cavern from a borehole, nowadays, no diesel blanket is used, as the selective leaching ensures that the halite cavern roof is not dissolved.
Nedmag owns 13 wells. Originally, these had separate caverns. Over time, 9 of the caverns became connected, resulting in a cavern cluster. In April 2018, this cluster contained 7,5 million m^3 brine, of which about 50% is locked in, in insolubles and precipitates.
At 20 April 2018, a sudden pressure drop occurred in the cluster. The pressure dropped by about 25 bar after 1 day and by about 30 bar after 2 days, after which the situation stabilized.
As root cause, a fracture in the roof above one of the upper caverns in the cavern cluster was identified. The fracture occurred despite the fact that the cavern pressure was about 15% below lithostatic. This was analysed (via a Finite Element analysis) to result from stress relaxation in the halite roof due to halite creep and arching effects from the stiff elastic overburden (Bunter formation). A fracture in salt is capable of closing again, halting brine flow, as soon as the brine pressure drops below the minimum salt stresses. This is what happened after a few days according to thorough analyses of cavern response and subsidence (via InSAR), where it is believed that the cavern cluster is once-more leak-tight since early May 2018 and will be, unless the cavern pressure is raised again to the fracture reopening pressure (which will not be allowed to happen in the years to come).
The cavern cluster brine pressure was lowered to a level of about 6 bars below the apparent fracture closure pressure. Until now, this pressure is maintained by controlling the cavern system bleed off flow.
The fluid which escaped from the cavern cluster was $MgCl_2$ brine. It might have contained some diesel, dating from the 1970's to 90's, when diesel blankets were still in use. To estimate the risk of fracture growth into the sweet water aquifers and pollution of these with brine or diesel, the fracture growth was modelled and diesel behavior was investigated. It was concluded that it is highly unlikely that brine or diesel could have reached the shallow subsurface, due to leak off in deeper layers. Nevertheless, a monitoring process was developed, using a 400 m deep surface casing plus a number of water extraction and monitoring wells. No diesel or elevated magnesium levels have been found.
To confirm that cavern system pressure reduction had stopped underground leakage, a comparison was made between squeeze rates from cavern cluster mass and volume balances and soil subsidence volume rates, measured by InSAR. In case of no underground leakage, the two rates should be similar, which proved to be the case.
The situation has been handled with a lot of focus on preventing and mitigating risks for Nedmag's surroundings.
Learnings from what happened are included in Nedmag's new mining plan, submitted to the Dutch authorities in November 2018.

Key words: **r**ock salt, salt caverns, cavern abandonment, rock mechanics