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Preventing subsidence caused by cavern migration in Hengelo and Enschede, The Netherlands

A risk based approach to monitoring and backfilling potentially instable caverns in the Hengelo brinefield, The Netherlands

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Abstract

AkzoNobel mines salt from caverns between the cities of Hengelo and Enschede at depths of 350 to 550 meter (1150-1800ft). The development of the brinefield comprises 4 phases:

1. 1934-1958: 53 wells from which 42 caverns were developed
2. 1958-1975: 225 wells from which 94 caverns were developed
3. 1976-2005: 213 wells from which 72 caverns were developed
4. 2006-2017: 66 wells from which 65 caverns are being developed

In the oldest part of the brinefield the leaching took place in a less controlled way than would be acceptable today. Most of these caverns migrated through the overburden and in some cases, caused significant surface subsidence. Currently, the rate of subsidence of those caverns has decreased to a few millimeters per year. Over time, AkzoNobel improved its controlled cavern leaching methodology, by the use of a blanket medium, sonar measurements and completion adjustments. Despite these control measures some “over mining” did occur, resulting in potentially instable caverns and subsequent risk of surface subsidence.

In 2004 the so-called Good Salt Mining Practice (GSMP) was developed for the Hengelo brinefield, defining guidelines to prevent over mining. One guideline is to maintain a minimum roof thickness to ensure cavern stability. Another guideline is inherent safety, which means that the height of the cavern is limited such that possible cavern migration will cease before causing significant surface subsidence. It was found that the caverns developed after 1975 are compliant with the GSMP guidelines. In contrast, 41 caverns from the second phase of brinefield development lack sufficient roof thickness *and* are not inherently safe. Another 11 caverns do have sufficient roof thickness, but are not inherently safe. Although migration has not started in any of these caverns, without taking measures future subsidence risk cannot be excluded.

To prepare measures, AkzoNobel re-assessed the risks associated with these 52 caverns based on current knowledge. As a result, AkzoNobel and K-UTEC developed a fit-for-purpose microseismic monitoring system to pro-actively reduce the subsidence risk. This system enables identification of cavern migration right from the onset. A pilot monitoring system was installed and successfully tested in 2016 and the system is currently extended to cover the full area with wells drilled between 1958 and 1975. It is worthwhile noticing that the system recorded a microseismic event in February 2017 which was caused by the development of a stress relief crack above one of the caverns. Further measures in preventive risk reduction are backfilling caverns with solids from AkzoNobel’s brine purification process based on risk prioritization and further study of the parameters controlling cavern migration and surface subsidence.

Key words: subsidence prevention, risk analysis, microseismic monitoring, cavern backfilling