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# Case Study to Evaluate the Rock Pressure Development at Reconstructed Gas Storage Caverns

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## Abstract

After many years of gas storage operation cavern wells should be recompleted as state of the art. During the reinstallation of cavern wells in rock salt formations the old completion including the production casing string has to be removed. It is also necessary to remove the whole cementation to establish a good new bond between cementation and the host rock later. However, during reinstallation of cavern wells a larger open-hole diameter has been developed compared to new drilled wells.

In case of new drilled wells in an unworked rock mass it can be assumed that the casing is relatively fast fixed by the surrounding rock mass. In addition to a perfect performed cementation of the production casing string the technical tightness of the cavern especially in the interval of last cemented casing shoe depends on the stress distribution in the surrounded rock mass.

But, in case of several reinstalled caverns (in relative shallow depth) it had been shown that the required horizontal confinement conditions acting between rock salt and casing installation could not be reached. Therefore, it has been assumed that the confinement depends on a time dependent pressure build up according to cavern depth, rock temperature and creep behaviour, i.e. the acting rock stress and also the maximum gas bearing capacity of the installed completion will time-dependent increase.

The problem was to determine the pressure limit for the MIT for recompleted caverns shortly after cementation (e.g. within 3 months) and to predict the medium term development of the stress distribution surrounding the bond rock salt/cementation/casing at the casing shoe level.

To prove the time dependent pressure build-up a numerical modelling has been performed. The model as part of a FDM-simulation (Finite Difference Method) was calibrated with reference to successful mechanical integrity tests (MIT) carried out on different caverns.

A visco-elasto-plastic constitutive law developed by IfG was applied for modelling the time-dependent creep, the stress-deformation and the softening behaviour as well as associated dilatancy processes. Input data for salt and cement were determined by laboratory tests also carried out by IfG.

Extensive simulations have been carried out also including the cavern history to show the influence of the cavern life time to the mechanical salt behaviour. Furthermore, two different cavern depths were investigated to find out their influences. The simulations of the stress and strain conditions in the cavern surrounding rock mass allow to predict the time-dependent increase e.g. of the horizontal confinement conditions acting at the casing shoe and furthermore, to define the acceptable maximum pressure for the cavern storage regime.