

THE BERNBURG TEST CAVERN – A MODEL STUDY OF CAVERN ABANDONMENT

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Abstract

The purpose of this paper is a presentation of test results focusing on the behaviour of a sealed and abandoned cavern. It depends on the system's geomechanical and hydraulic properties and their interactions.

For a better understanding of these interactions, an extensive research program comprising in-situ tests, rock mechanical investigations and modelling has been done in the Bernburg salt work since 2001. Major part of the program were the pressure build up tests at various volume scales in boreholes (20000 cm³) and a test cavern (22m³) for over 2.5 years. To interpret the results the rock mechanical program covers the following points:

1. the deformation behaviour of the surrounding rock mass.
2. the stress state in the solid by hydro-fracturing.
3. the rock mechanical behaviour of rock salt samples from the surrounding rock mass.
4. the property of pressure transmission by packer seal made out of elastomer.

Finally, the observed time dependent processes were numerical modelled using a modified FLAC-Code.

In two brine-filled drill holes of 44 mm diameter and a length of 25 m (sealed 10 m behind the wall) the time dependent pressure development was observed at different levels between 10 and 100 bar for 8 to 18 weeks at each step. The pressure build-up behaviour of the drill holes was investigated applying constant pump rates between 10 and 700 cm³/day. Constant pressure levels were detected of about 90 to 100 bar (85 - 95% of the lithostatic pressure) depending on the pump rate. Based on rapid pressure increase or decrease cycles a specific pressure rate between 0,6 and 0,8 bar/cm³ has been determined equivalent to the compression module for the rock salt/brine system of 1,7 GPa.

After leaching the nearly ideal cylindrical brine-filled test cavern the tightness of the sealing system was tested with nitrogen at a pressure of 20 bar. In the following 28 month brine pressure build up tests carried out between 10 and 90 bar. Time dependent pressure development was observed for periods of 2 to 4 months. More then 350 litres fluid were leached during constant pump rate tests by pump rates between 1 and 175 litres/day. In accordance with the pump rate, pressure levels were reached between 80 and 90 bar, remarkable lower than observed in the drill holes.

After finishing the tests and emptying cavern the contour of the cavern has been probed by a 101 mm drill core ensuring direct determination of extension of the brine penetrated zone and its porosity.

Key words: Cavern Abandonment, Long term Behaviour of Brine Filled Caverns, Instrumentation and Monitoring, Rock Mechanics