

## FLOODING AND RECOMPLETION PROJECT OF SALT CAVERN TO-8 LL. TORUP, DK

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### 1 Abstract

The gas storage caverns at Ll. Torup, Denmark, were built in the 1980s in the course of the energy crisis as part of the Danish Energy policy. At this gas storage facility in Ll. Torup the only gas storage salt caverns in Denmark have been operated since 2007 by Energinet.dk Gas Storage. After more than 20 years of gas operation Energinet.dk considered the flooding and recompletion of the seven gas storage caverns at Ll. Torup, starting with cavern To-8 in 2011 as a pilot project. The project – especially the completion operation – is mainly motivated by safety reasons, i.e. installing state of the art equipment, such as a surface controlled subsurface safety valve (SCSSV) and new sealing elements (packer). This kind of refurbishment will become more and more important to cavern operators in the coming years, since a number of storage caverns in Europe have reached a lifetime of several decades.

KBB Underground Technologies GmbH was responsible for planning and technical support of the whole campaign in Ll. Torup, comprising snubbing, flooding, re-completion, gas tightness test and gas refill.

As a preparatory work before completion operation the cavern has to be emptied of the stored gas. For this purpose a flooding string is installed under gas pressure down to the brine filled cavern sump. The cavern is then filled with water via the flooding string, while the gas is withdrawn through the annulus between gas production tubing and flooding string subsequently. Apart from increasing the safety of completion works the flooding also has the benefit of increasing the cavern volume and therefore the working gas volume.

The recompletion works start after the cavern is filled completely with water. The old gas production tubing is replaced by a new welded gas production tubing, including a packer and a surface controlled subsurface safety valve (SCSSV). After the completion for gas operation and the confirmation of the cavern's integrity in respect to gas at the area of the last cemented casing shoe, the cavern is connected with the gas first fill equipment at surface and natural gas will be injected for the first time after recompletion. Once all brine has been displaced to the depth of the casing shoe of the debrining string, it will be removed with a hydraulic workover unit (snubbing unit) under gas pressure. The cavern is then ready for gas operation.

Apart from the technical procedure for cavern flooding and recompletion, the flooding and gas refilling process were strictly limited regarding freshwater intake from and brine disposal into the local fjord. During these processes the very strict requirements of the Danish environmental authority, as well as those of the Danish public, had to be accounted for with challenging prospects for the project.

The technical, as well as the approval, process regarding the flooding and recompletion project in Denmark and the related challenges will be described and analyzed in the paper.

**Key words:** Caverns for gas storage, gas storage, flooding, re-leaching, gas withdrawal, re-completion, gas re-fill