Leak Detection and Determination of the Fluid Level in the Annulus in the Kiel Underground Gas Storage Facility (Germany) using Fibre Optic Temperature Measurements

Grosswig, St.*, Hurtig, E.*, Muecke, L.** and Schneider, R.***
*GESO GmbH Jena, **Stadtwerke Kiel AG,
***DEEP. Underground GmbH, Bad Zwischenahn

Abstract

Temperature distribution measurements made simultaneously along the full length of a production string under varying operating conditions and especially before, during and after pressure drawdown in the annulus provide detailed information on temperature anomalies which may be due to leaks from the production string (e.g. at corrosion pits, collars, screwings, simple or over-shot sealing units and travel joints) or the casing or to flows occurring behind the casing. Because of the Joule-Thomson effect, any leak will result in a temperature drop. By comparison with defined starting temperature conditions, leaks can thus easily be detected and located. Using conventional temperature well logging it is not possible to measure temperature vs. depth and time simultaneously for the full length of a production string with a high depth and temperature resolution. Fibre-optic temperature sensing opens up new possibilities for measuring the time-depth distribution of temperature. This method can also be used to determine the level of the protective fluid in the annulus.

The results of fibre optic temperature measurements in a well of the Kiel underground gas storage facility of the Stadtwerke Kiel reveal the capability of this method. The well was completed using a welded production string. The fibre-optic temperature sensing cable was installed inside the production string. First the annulus stress was removed. With the annulus stress removed, the leak is stimulated and gas starts to flow from the string into the annulus while the temperature decreases. Though the annulus pressure rebuild after the pressure drawdown was very low, the position of the leak could be determined exactly. From the combined effects of annulus stress removal, gas withdrawal and temperature relaxation after gas withdrawal the position of the depth of the protective fluid in the annulus was exactly determined.

The results show that fibre optic temperature measurements can be taken in cavern storage facilities without any redesign or technical modifications at the well head or inside the string and without extended disruptions to storage operation. The fibre-optic temperature measurements were an efficient diagnostic tool and of great benefit to the operation of the Kiel underground gas storage facility.