EAGE

Fr SR 06

DTS Measurements in Oil and Gas Production and Storage Wells

S. Grosswig* (GESO GmbH & Co. KG Project)

SUMMARY

The temperature distribution inside a production well or inside a storage facility and its variation with time and depth are key parameters for assessing operating conditions. In combination with geological and petrophysical data, long-term temperature monitoring of underground storage facilities can provide thermodynamic information on reservoir dynamics. The storage capacity (gas volume and injection/ withdrawal rates) strongly depends on temperature. The same is true for the dew point, the vapour pressure and chemical reactions. Knowing exactly about temperature vs. depth and time in a production well of a cavern or aquifer storage facility is crucial when it comes to optimizing the methanol inhibition regime (methanol/glycol) and the operating conditions. From a known well head pressure and the thermodynamic equation of state one can derive the pressure profile based on the temperature profile. Moreover, the temperature dependence of pressure opens the chance to measure and survey fluid levels in aquifer boreholes.

The temperature distribution inside a production well or inside a storage facility and its variation with time and depth are key parameters for assessing operating conditions. In combination with geological and petrophysical data, long-term temperature monitoring of underground storage facilities can provide thermodynamic information on reservoir dynamics. The storage capacity (gas volume and injection/withdrawal rates) strongly depends on temperature. The same is true for the dew point, the vapour pressure and chemical reactions. Knowing exactly about temperature vs. depth and time in a production well of a cavern or aquifer storage facility is crucial when it comes to optimizing the methanol inhibition regime (methanol/glycol) and the operating conditions. From a known well head pressure and the thermodynamic equation of state one can derive the pressure profile based on the temperature profile. Moreover, the temperature dependence of pressure opens the chance to measure and survey fluid levels in aquifer boreholes.

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, thus leaks can be detected and located easily.

Determining these parameters requires a technique which allows measuring temperature vs. depth and time simultaneously for the full length of a production string with a high depth and temperature resolution and with a high logging rate (30 seconds or 1 minute) over periods of several hours or days. This kind of data cannot be obtained using standard well logging techniques. Fibre-optic temperature sensing meets these requirements and hence opens up new possibilities for detecting and monitoring processes in production wells of storage facilities and producing oil and gas fields. General, the distributed fiber-optic temperature borehole measurement is suitable

(a) for temporary sensor cable installation in the production riser (measuring time: hours to days) or
(b) for the permanent installation of the sensor cable in the annulus in case of long-term online monitoring or as a "sleeping sensor".

First fibre optic distributed temperature borehole measurements were taken by the author in 1992 in the well Mittenwalde 5. Since then, the company GESO has monitored more than 150 different boreholes in Central Europe.
In the paper measuring results of typical application examples of the fiber-optic distributed temperature borehole measurements are presented:

- detection of untight collars, travel joints and packers,
- detection of gas migration path in the cementation,
- detection of inflow areas in steam stimulated horizontal oil production wells,
- tightness proof of the geological barrier of a reservoir water re-injection well,
- determination of top of cement,
- determination of the blanket brine interface level during the leaching process of salt caverns.