Goldschmidt 2024 Abstract
https://doi.org/10.46427/gold2024.23788

Pressure oscillations associated with warming in a deep CO_2 injection well

STEPHEN J TALMAN AND RICHARD J CHALATURNYK

University of Alberta

Presenting Author: stalman@ualberta.ca

While the association between CO_2 injection projects and hydrothermal systems may seem tenuous, some aspects are similar. Both involve flow, possibly intermittent, of a single-phase fluid along a path into critical, or near-critical conditions. However, the bottom hole pressure (BHP) and temperature (BHT) of CO_2 injection wells can be monitored under controlled conditions at depths of several km. As such, unexpected or hard-to-explain behaviours during CO_2 injection may be worthy of consideration in other contexts.

As part of the ongoing Aquistore CO_2 (Saskatchewan) injection project, surface and subsurface (~3 km,) temperatures and pressures are routinely collected. Unexpectedly complex BHP signals are commonly seen shortly after injection is paused. Gas injection leads to local cooling along the well bore and into the host reservoir. On shut-in, initially both the observed BHT and BHP return smoothly towards far field values. However, in many instances, after a day or so, the BHP began to increase, with the general warming not being affected (see Figure). The calculated fluid density also falls initially, but it remains surprisingly constant during the time when the BHP is increasing. After some hours to days, the BHP and density both drop rapidly, after which the BHP begins to increase again. The initial, smooth behaviour is a consequence of warming and expansion of CO_2 within the wellbore. This drives CO_2 from the wellbore and the associated head loss is reflected in the BHP drop. With time, this heat and mass flux decays. A similar warming and expansion also affects the injected CO_2. The reduction in drive from the wellbore allows the horizontal expansion of CO_2 in the reservoir to drive material back up the wellbore. As this CO_2 is pushed, plug-like, upwards the BHP increases while the CO_2 column becomes increasingly unstable. Eventually, the column collapses, and the BHP drops. This transition may be due to the local thermal gradient increasing above ~9 K/km which is a critical value below which convection will be absent. Heat redistribution may temporarily be more efficient by a bulk upward flow from the reservoir than by convection.