Injection Fall-off Testing using the SPIDR® Gauge

Testing wells from the surface has become increasingly accepted from operators both in conventional gas and gas condensate PTA applications but more recently in injection fall-off testing. Operators are demanding a higher quality pressure gauge, one that incorporates DUAL QUARTZ crystalline sensors. The pressure sensor used in the SPIDR® gauge is a dual quartz resonator which changes frequency in response to pressure. Because frequency (and its inverse, time) can be measured with greater precision than any other parameter, the sensor's frequency output provides high resolution pressure measurement. Quartz is a nearly perfectly elastic material, providing sensor stability and repeatability. When compared to lower quality strain gauges the SPIDR® gauge exhibits much better resolution, stability of pressure response with changing temperatures and virtually no hysteresis. Operators are concluding the necessity for Dual Quartz Gauges especially when they intend to utilize the data for transient analysis, regardless if the data is captured on the surface or downhole.

Injection fall-off testing has taken on two distinct forms. The first, a pre-frac injection fall-off tests normally is utilized in ultra low permeability conventional tight gas sands or increasingly in shale plays. A small amount of clear fluid is pumped to induce a fracture. Once induced the pump is shut down, the well is shut-in and allowed to fall-off. The duration of the fall-off can run anywhere from 24 hrs to up to and beyond 30 days. The second form of fall-off test is a H₂O, N₂ or CO₂ flood where an injector well that has been continuously injecting is shut-in and the pressure is allowed to fall-off. This is normally a short duration test, less than 48 hrs.

If you expect to have a positive pressure on the surface and you have a fluid in the wellbore with a known density, then the use of a surface pressure gauge is a NO RISK and LOW COST preferred option. We have talked to several operators who have compared pressure data sets from the SPIDR® gauge at surface and gauges run downhole and they conclude that the SPIDR® gauge fulfills their needs in pre-frac injection fall-off applications. BUT, they also say that if they are to use a gauge at surface it should have the desired RESOLUTION (at least 0.01 psi) the ability to gather pressure data FREQUENTLY (at least one sample (1) per second) and STABILITY in the data (minimal ambient temperature response). Stability of the data is important because many of the curves used in the analysis of these “G” function (DFIT™ Service/MFO) tests are numerically differentiated and any instability will render the diagnostic plots useless.

For water, N₂ flooding applications, surface testing is straightforward. For CO₂, phase changes can be problematic for pressure data captured at the wellhead depending on the conditions present (pressure / temperature) when CO₂ is being pumped and the fall-off. On CO₂ injectors, we would like to perform more comparison (SPIDR® gauge in conjunction with downhole gauge) work over a wider range of conditions in order to better understand surface data acquisition limitations. The SPIDR® gauge is also used for Step Rate and interference / communication testing for flood optimizing purposes and to understand the impact of stimulation stages in offset wells.

The above listed and desired specifications result in the requirement for a DUAL QUARTZ type pressure transducer. The DUAL QUARTZ type transducer of a type manufactured by Quartzdyne, and included in every SPIDR® gauge, is considered one of the most advanced pressure transducers in the oilfield today.

Because the use of surface pressure data has not been historically used for pressure transient analysis, the quality of the data has not been stressed by operators whether working on or offshore. Through the technology advancements of more accurate conversion algorithms along with improvements in transducer and gauge quality characteristics, surface pressure measurement is gaining acceptance as a viable LOW COST and NO RISK alternative to deploying slickline and pressure gauges downhole for pressure transient analysis purposes.

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