NEW ENERGY SOLUTIONS

Downhole Discrete Fiber Optic Pressure and Temperature Monitoring in a Carbon Capture Injection Well

OPTICAL SENSING IN CCS SURVEILLANCE

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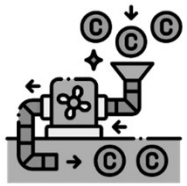
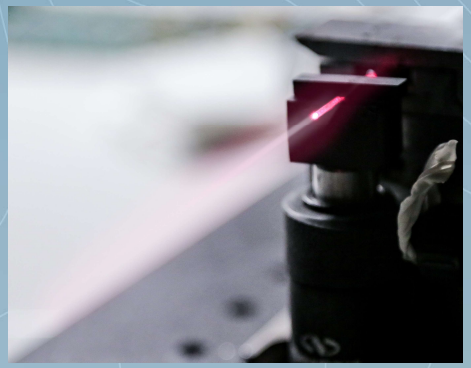
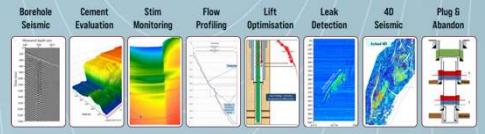
Weatherford®

OBJECTIVE

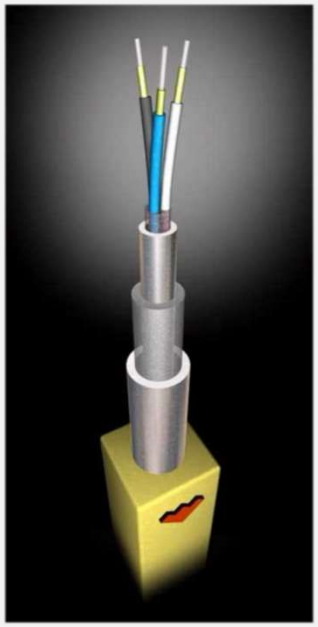
- Monitor near-wellbore conditions during CO_2 injection testing
- Collect reliable, high-resolution pressure & temperature data
- Integrate PT with DAS/DTS without compromising depth/coverage
- Trial CCS-duty FO equipment in field environment.



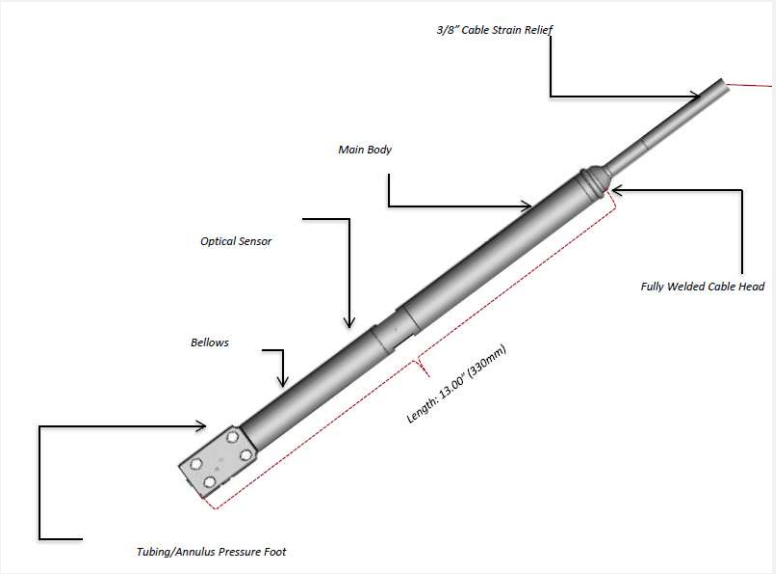


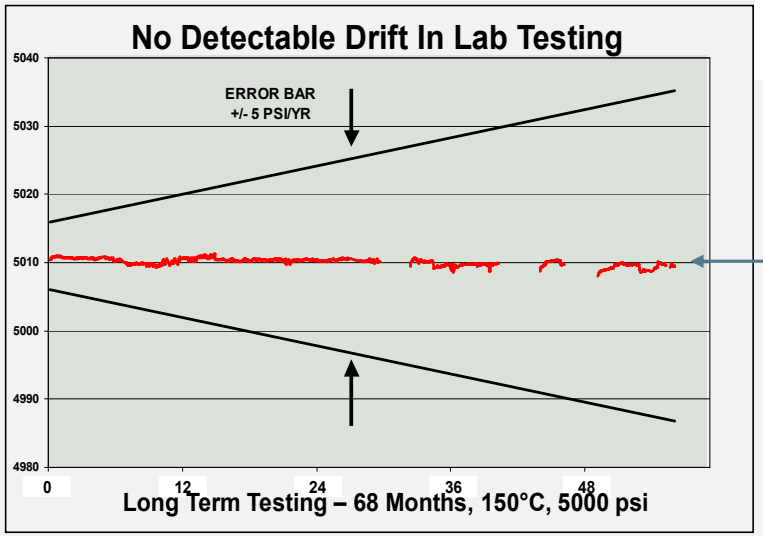


OPTICAL PRESSURE AND TEMPERATURE SENSING



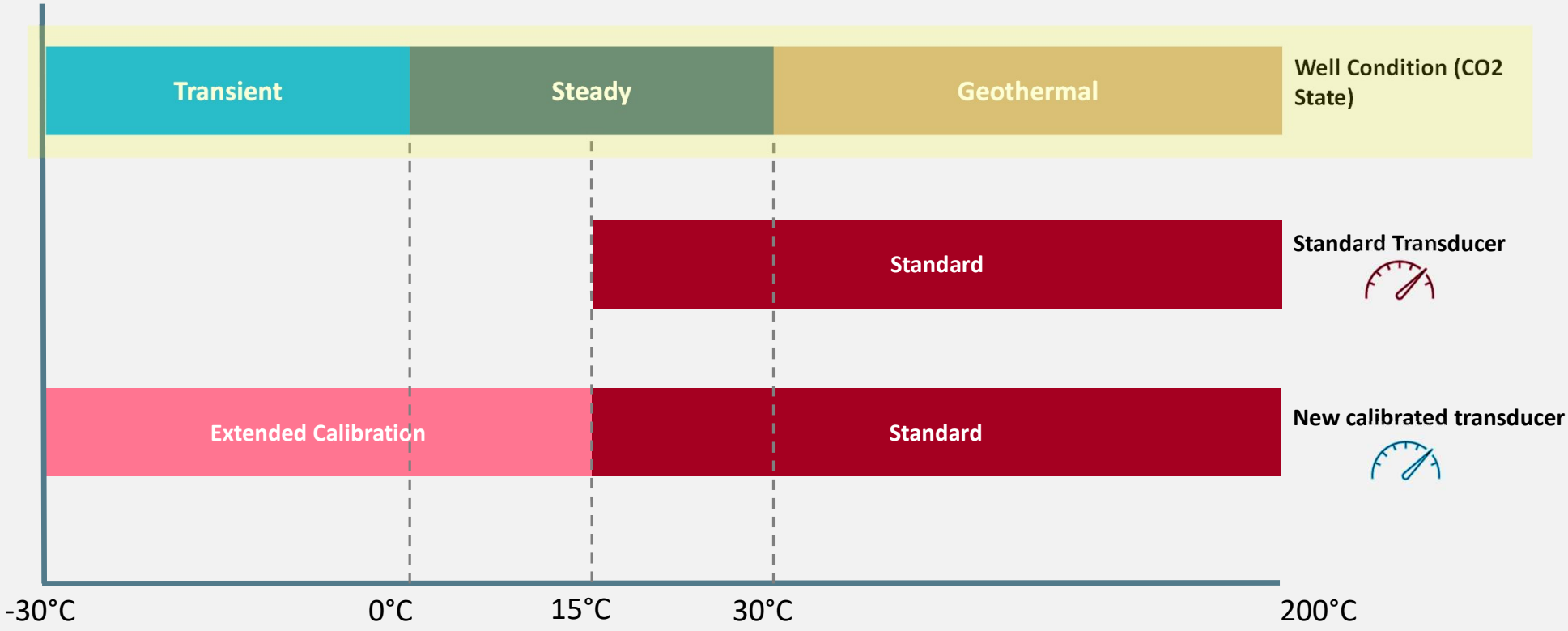
- No downhole electronic/ moving parts
- Vibration and shock tolerant
- Multidrop gauges (up to 12 gauges per cable)
- All welded construction
- > 1000 sensors deployed



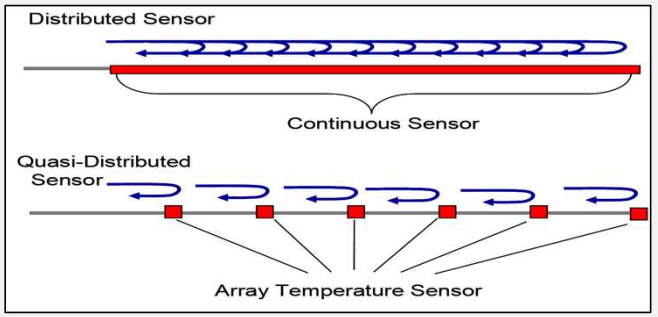


Press. Resolution	< = 0.02 psi
Press. Stability	< 0.05 psi / year
Press. Accuracy	+/- 0.5 psi
Temp. Resolution	< / = 0.02 °C
Temp. Stability	< 0.18 °C / year
Temp. Accuracy	+/- 0.1 °C

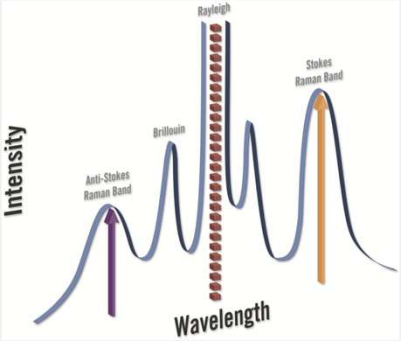
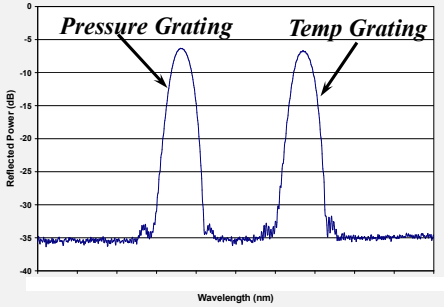
OPTICAL PT TECH ADAPTATION: TEMPERATURE CALIBRATION



DISCRETE & DISTRIBUTED MEASUREMENT



Operating principle for integration of data stream

Distributed	Raman Effect. DTS instrument measures Raman Backscatter (Stokes and Anti-Stokes) Brillouin effect. DTS single mode, DSS Rayleigh effect. DAS instrument, scattering effect by sound.	
Discrete	Optical reflection. Bragg Grating; change in direction of a wave, strained applied by pressure and temperature changes,	

PT & DFOS INTEGRATION FOR C02 INJECTION TEST

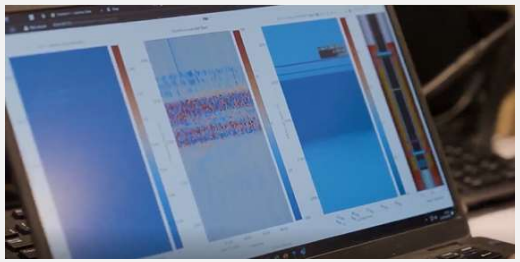


Photo courtesy of Perenco CCS

- "First of its kind" injection test in depleted reservoir *(former largest gas field in North Sea)*
- **Optical Equipment**
  - Multi-drop PT gauge: Tubing/Annulus Sensing (Upper & Lower)
  - Fiber run from top to toe of completion
  - PT & DAS DTS across injection zone
- **Monitoring objectives**
  - Phase Verification & Injection Profiling
  - Plume Migration & Micro seismic detection
- Fully integrated data management with remote monitoring

LESSONS LEARNED & CONCLUSIONS

Discrete measurement in an injection test

- Optimizing surface configuration with relative downhole pressure/temp data
- Heat coefficient and density changes
- Critical for monitoring during transient phase
- Saturation pressure at injection zone, to perform seismic survey

Integration of discrete and DFOS

- Simplification of permanent monitoring system
- Enhance reference points for DFOS measurement for further quantitative interpretation
- Streamlined installation steps improved field execution success rate
- Validated fiber optic readiness for CO_2 service, proving field applicability

Questions?

ACKNOWLEDGEMENT

PERENCO

Perenco CCS (Carbon Storage)