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A Case Study in Enhanced Well Integrity Diagnostics Using Distributed Fiber Optic Sensing (DFOS) in the Brazil Campos Basin

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Abstract

Tubing to annulus communication is a common integrity failure in mature wells and remains one of the most difficult to diagnose using conventional evaluation methods particularly in cases where intermittent, low rate, or pressure dependent flow paths evade traditional logging. This paper demonstrates an integrated workflow combining fiber optic analysis to transform a complex integrity challenge into a clear flow diagnosis.

A slickline-deployed fiber optic system enabled the surveillance over the entire tubing length during a controlled tubing and annulus pressurization and bleed-off sequences. High-resolution temperature and acoustic data were acquired over multiple flow regimes. Temperature responses were enhanced through low frequency acoustic processing to identify thermal changes. Cross-domain data integration enabled separation of leak-driven flow from operational effects. Gigabytes of raw data generated by fiber were preprocessed offshore using advanced compression and filtering techniques, reducing the volume to megabytes and enabling rapid data transfer.

Distributed Fiber Optic Sensing (DFOS) interpretation revealed a dominant leak path driving annular communication, supported by persistent acoustic energy and progressive thermal contrast. Gas-lift mandrels displayed intermittent operation, indicating variable valve behavior under different pressure regimes. Fluid movement patterns reflected complex multiphase interactions within the wellbore.

The combined data enabled differentiation between structural leakage, valve activity, and operational events. Unlike conventional PLT based diagnostics, DFOS enabled continuous depth coverage. The findings demonstrate that DFOS can deliver leak localization, and valve diagnostics simultaneously using a single rapid intervention. Data were streamed in real time and interpreted by an onshore engineering team, enabling rapid diagnosis within hours after acquisition and direct support to field decision-making.

This paper introduces a practical framework for integrity-focused fiber optic interpretation in the Campos Basin, Brazil, demonstrating the value of distributed measurements setting a foundation for DFOS as a decision-support tool in well integrity programs.
