Introduction
This article explores challenges many Operators face today—the compliance of reservoir and completion performance to field development plan in order to maximise longevity of optimal production. In this article we examine the importance and added value benefits of acquiring Spectral Noise Logging (SNL) and conventional Production Logging Tool (PLT) data to this effect. We refer to previously published case studies for which spectral noise logging and conventional PLT data allowed oil and gas companies to resolve poor performance issues in both production and injection wells; reviving overall production levels and sustaining field life.

Reservoir and Completion Component Flow
Reservoir flow noise is produced by grain-to-grain, pore throat and fracture vibrations caused by transfer of energy from the flowing fluid to the media. Completion flow noise is typically generated by the vibration (resonation) of the production string (tubing or casing), pipe through-holes (leaks), perforation tunnels, and cement channels. Each source of noise can be distinguished based on acoustic frequency range, amplitude and continuity of the signal with wellbore or reservoir unit limits. Combining SNL and temperature measurements with conventional PLT measurements from flowmeters, heat exchange sensors, etc. allow for differentiating between flow occurring within the borehole or that behind pipe. In the same way assessment of reservoir performance (SNL) and completion performance (PLT) is achieved, all with the same survey run.

High Precision Temperature Logging
Though temperature logging has been extensively used over several decades, the more recent development in simulation methodology and advanced numerical temperature modelling has enabled better interpretation and understanding of fluid flow. The methodology includes thermal model validation and accounting for injection/production history fluid volumes and temperatures. Additionally, the sensitive input parameter, of active unit thickness which previously has been assumed from open-hole logs, is now measured directly with the Spectral Noise Logging tool. This data acquisition now aids in a more robust and representative quantitative determination of fluid flow profile.

Spectral Noise Logging
The Spectral Noise Logging tool is specifically designed as a passive acoustic hydrophone, recording sound in the frequency range of 8Hz to 60kHz. The Spectral Noise Logging captures noise associated with liquid or gas movement through a media. This noise is generated from the streamlining (vibration) of the media and from within the fluid itself (if flow is turbulent). The frequency of the noise is inversely proportional to the cross sectional area (aperture) of the flow path. The volume intensity (amplitude) of the noise is dependent on the fluid and medium properties, and proportional to the delta pressure and flowrate.

The SNL tool is used to survey producer and injector wells, under both shut-in and flowing conditions. For shut-in surveys SNL captures noise associated with any cross-flow, crucially fluid cross-flowing behind completion components (tubing and casing). This allows for assessment of completion performance isolation (cement, packers, SSDs, etc) and realisation of inter-layer differential pressure depletion. Under flowing conditions SNL captures noise associated with reservoir flow, enabling assessment of layer performance (e.g. for identifying stimulation candidates) and out of zone contributions (water breakthrough/thief injection).

Injector Wells
The primary objective of injector wells is to ensure that water or gas is effectively placed into the targeted formation layers, to maintain reservoir pressure and mobilise hydrocarbons. Failures in completion component isolation (principally cement sheath or ISO-packers) can result in significant volumes of injected fluid bypassing the target zone. Insufficient layer pressure support and reservoir sweep results, causing reservoir conditions to deviate from field development plan and negative impact on production forecasts and recovery factor. Furthermore, if a polymer or surfactant injection is planned, it is important the calculation factor. Furthermore, if a polymer or surfactant injection is planned, it is important to calculate the injection intensity (amplitude) of the noise is dependent on the fluid and medium properties, and proportional to the delta pressure and flowrate.

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Spectral Noise Logging For Injectors:
- Locate and constrain limits of injection into layers behind pipe (within and out with perforation interval)
- Detect and differentiate between wellbore and behind casing cross-flows

Spectral Noise Logging For Producers:
- Locate leaks occurring across any completion components (tubing, casings, packers, completion jewellery, cement)
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Conclusion
Assessing reservoir and completion performance is critical for effective reservoir management; sustaining optimal productivity and maximising recovery. Spectral noise logging captures and distinguishes between noise generated from flow occurring within the completion itself (leaking pipes and packers, cement channels, etc.) and flow happening 3 – 5 meters into the formation itself (matrix and fractures).

Spectral Noise Logging For Producers:
- Locate and constrain limits of producing layers behind pipe (within and out with perforation interval)
- Detect and differentiate between wellbore and behind casing cross-flows
- Identify leaks occurring across any completion components (tubing, casings, packers, completion jewellery, cement)

Continuous solids removal assures continuous production
by Giedre Malinauskaite, FourPhase

There are a number of aging oil and gas wells in production globally in addition to an increasing number of HPHT wells being drilled and set in production. Both aging wells and HPHT wells have significant challenges related to solids control while at the same time maintaining optimal well flow.

With these challenges present the Oil & Gas Industry must focus on working smarter and more efficiently. There has never been a greater need to apply new technology and implement innovative solutions. It is a fact that solids removal technology plays a major role in materially reducing costs and improving production efficiency in solids producing wells.

Solids removal technology enables Operators to increase the flow rate from producing wells while at the same time staying within the acceptable sand rate (ASR) criteria. This results in improved oil recovery at a lower cost per barrel. Solids removal technology provides a proven solution to maximising profit from each barrel of oil and/or gas. While the oil price is not something Operators can directly affect – increased production rates can compensate for loss of revenue while the oil price stays low. Further, solids removal technology reduces all direct and indirect costs related to reactive sand management:
- Well intervention activities such as coiled tubing (CT) and snubbing clean-outs
- Separator cleaning and sand handling
- Erosion of process plant
- POB necessary for doing maintenance on equipment suffering from sand production

Gulfstream C, Statoil has been among the pioneers in implementing FourPhase’s continuous production unit – DualFlow. In the paper presented by Statoil at SPE Sand Management Forum in 2014*, Statoil highlighted the benefits achieved by installing the DualFlow unit for continuous solids removal. According to the presentation, FourPhase’s technology resulted in operational benefits (less jetting work, reduced sand problems in process plant, only one rig-up), cost savings (sand handling done offshore by reinjection, less need for CT sand clean out, more time for alternative CT operations) and improved oil recovery (higher flow rates without exceeding ASR, less down time for wells, optimised well performance).

FourPhase has proven to highly reduce and, in some cases, eliminate the need for costly intervention operations. In addition, providing uninterrupted continuous production.

Contact us to learn more about how FourPhase can revolutionize sand management on your installation.


Figure 3. Underlying aquifer contributing water to perforation interval via cement channels

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