Technology overview

Expro's emergent Cableless Telemetry Technology (CaTSTM), which was recently recognised with the Innovator Award at the SPE Offshore Achievement Awards (March 2015), is being embraced across the global industry as a key solution to reduce reservoir development risk, optimise production and to enhance well safety.

Based on electromagnetic (EM) data communications technology, the CaTS system wirelessly transmits high quality pressure and temperature information from the reservoir to seabed using the well's tubing, casing or liner as the transmission medium. Signals can also be transmitted from seabed to reservoir to command and control downhole hardware such as flow control devices.

Under favourable well conditions the CaTS wireless technology has achieved very long point-to-point transmission ranges in excess of 12,500ft without requiring any relay or booster stations to be installed in the well. By reducing the quantity of in-well equipment the deployment time and monitoring costs are minimised.

Of critical significance and unlike competing wireless technologies, the CaTS technology does not require a tubing string in the well to communicate and the signal is not attenuated by cement plugs, bridge plugs or cemented casing or liner. This makes CaTS ideally suited to operating in the permanently abandoned well environment, where typically only cemented casing or liner strings remain in the well.

The system uses standard completion components so there is no requirement for special high cost plugs or packers with penetrations. It can be retrofitted into existing wells using either wireline or coil tubing, and can be externally or internally mounted on a tailpipe below a permanent packer during a drill stem test (DST). Alternatively, it may be deployed as part of a lower completion assembly for sandface monitoring.

Reducing reservoir uncertainty

Uncertainties in reservoir connectivity and compartmentalisation risk are major concerns when evaluating any new field appraisal or development option. Having a better understanding of reservoir connectivity can provide significant benefits in determining the most effective drainage strategy and optimising the field development plan.

One route to reducing uncertainty is to maximise the time spent on appraising the prospect. Both multi-well interference and long term pressure build-up testing provide valuable information about the connected volumes, but naturally there is always a time-cost pressure to minimise testing durations, especially in the high operating cost, deepwater subsea environment.

As a result, well testing operations may be terminated early, before there has been sufficient time for the pressure transient response - being monitored during a pressure build-up period - to adequately investigate any far boundaries. This can mean that critical decisions regarding future field development plans are taken based on limited and insufficient data sets. Through the application of CaTS, well testing no longer has to end at well abandonment. Expro's Advanced Reservoir TestingTM service now enables abandoned wells, zones or pilot holes to be monitored for extended periods beyond final well abandonment.

The post-abandonment reservoir pressure data is being used by operators to monitor for connectivity with adjacent assets that are either being produced, or injected into, and also to collect long term pressure build-up data to investigate far reservoir boundaries and establish connected volumes. This is proving to be highly valuable information that would not be detected during the course of a typical 48 or 72 hour pressure build-up performed during a DST. In either case, high value reservoir information is being collected over long monitoring periods and at low incremental well cost.

The pressure data is transmitted wirelessly using a digital signal, providing reassurance that there will be no loss of fidelity in the data quality resulting from the transmission process. Each gauge has its own signature, or address, meaning that multiple discrete zones can be monitored, with up to 20 zones having been instrumented successfully in a single well comprising stacked reservoir sands.

The pressure / temperature data being transmitted from downhole is stored at the seabed in a battery powered, remote subsea receiver, which is rated for operation at water depths of up to 10,000ft. The data is subsequently collected from the subsea receiver by periodically sailing a supply boat overhead the abandoned well location and uploading the data from the receiver's memory using wireless through-seawater communications.

Once installed in an abandoned subsea well there is no requirement to re-enter the well using a semi-sub rig; the only remaining abandonment liability is to sever and recover the wellhead at a convenient time in the future, which can typically be performed using a work vessel.

After initial successful deployments in abandoned appraisal wells on the UK Clair Field, the market demand for the CaTS Advanced Reservoir Testing service has seen accelerated growth. The technology has now been successfully applied to monitor the reservoir pressure response in permanently abandoned or suspended subsea wells in some of the world's most challenging and hostile deepwater provinces, including the Norwegian Barents Sea and the Santos Basin of Brazil.

Multiple abandoned wells have now been instrumented with CaTS and data has been successfully recovered wirelessly from wells having reservoirs located more than 10,000ft below the seabed and in water depths in excess of 7,000ft. These long transmission ranges have been achieved point–to-point without the need for any intermediate relay stations or boosters being installed in the well.

CaTS has also been successfully installed in exploration wells that are abandoned immediately after open hole logging has been completed and without any drill stem testing or flow backs having been performed. Despite never having been flow tested or cleaned up, excellent high quality data has been collected that clearly demonstrates the reservoir response due to interference effects resulting from production or injection events in the adjacent field area.

Enhancing well safety

There is an increasing industry focus on the development and application of new technologies for well integrity monitoring. Examples include the long term monitoring of the pressure in multiple annuli in subsea production wells and the verification of pressure barriers during well suspension or plug and abandonment (P&A).

The CaTS technology can be flexibly located in any annulus and the pressure and temperature data can be wirelessly transmitted to a seabed receiver without requiring any wellhead penetration.

In terms of barrier verification, the NORSOK Standard D-010 covering well integrity in drilling and well operations requires that a plug shall be verified to the maximum differential pressure at the time of barrier placement. The CaTS EM communications technology is unaffected by bridge plugs or cement plugs, making it ideally suited to both short and long term well integrity monitoring applications.

During workover or P&A operations it is common to install both deep and shallow set bridge plugs as temporary barriers at an early stage of the operation. In some wells it can be necessary to establish these two barriers deep in the well and relatively close together. The sealing integrity of the lower plug can generally be validated by pressuring up from surface and monitoring for any leakage using the surface pressure gauge. However, when installing the upper plug, and due to the relatively small volume of fluid between the 2 plugs, it is unlikely that a pressure test applied from surface will detect any leakage past the upper plug. Thus, when using surface measurements for verification of the upper plug, the results may be inconclusive.

By installing a CaTS wireless transmitting pressure gauge below the upper plug, it is now possible to monitor the pressure below the plug in real time at surface whilst the pressure testing operation is being performed. This operation requires no additional

equipment to be incorporated into the logging string used to deploy the plug and can be completed during a single run in hole operation, ensuring operational efficiencies whilst minimising costs.

Well abandonment barrier verifications have successfully been completed from light well intervention vessels on 13 subsea wells in Norwegian and UK sectors of the North Sea.

Production optimisation in high rate big bore gas wells

CaTS is also being applied in the large bore completion environment to deliver a sandface monitoring capability that has enabled production rates to be optimized in high rate gas wells Six large bore mandrel systems have been installed in the Shell-operated Ormen Lange Field in Norway. These systems feature full two-way communications between the mandrel located at the sandface and the onshore control room, enabling the gauge settings to be varied and pressure build-up data to be collected on demand. Data from this system has been used to optimise production across the entire field.

Conclusions

This emergent new wireless communications technology is seeing accelerated industry adoption for applications throughout the well lifecycle. Looking to the future the CaTS technology is being developed for both monitoring and control applications in Advanced Completions leading to the ultimate Expro goal of delivering the 'Wireless Reservoir'.

Brian Champion, Wireless Well Solutions, Expro

Brian Champion has a BSc in Geology and Physics and more than 35 years' experience gained in field, management and technical positions extending across cased-hole logging and intervention, well testing, drilling and completions. An author of 6 SPE papers and numerous journal articles, he has been involved with the development and leadership of the Expro wireless technology business since its start up in 2004, where his current position is Global Sales Director, based in the UK.