PROTECTING WELL SYSTEM INTEGRITY IN THE MIDDLE EAST

By: Ken Feather & Simon Sparke,
TGT Oilfield Services

Figure 1—*TGT's EmPulse characterisation and testing facility at its research, engineering and manufacturing centre in Kazan, Russia. The EmPulse system is tested and proven in a wide range of real-world well completion combinations.*

Total well system integrity and 'the containment and prevention of the escape of fluids' [ISO TS 16530-2] remains one of the biggest challenges Middle East operators face today.

The Middle East has been the world's most prolific oil-producing region for decades with one of the largest populations of 'hard-working' aging wells – many of which operate continuously in extreme environmental conditions. More than 70 per cent of the ~800 Middle East platforms and associated well-stock are more than 25 years old.

Not surprisingly, Middle East operators are facing a constant challenge to manage corrosion and sustained annulus pressure [SAP] in their well systems, and are always on the lookout for new innovations to help. This article will provide examples of two such innovations – corrosion surveillance in chrome-based tubulars, and addressing SAP.

Overcoming chrome

As Middle East well conditions become more corrosive, so operators have looked to more corrosion resistant materials in the completion process, leading to a rise in chrome and nickel content in steel tubulars. However, one unintended side effect is the decrease in the effectiveness of ordinary electromagnetic [EM] well and pipe inspection systems and the tracking of corrosion in multiple barriers.

The increase in chrome and decrease in ferrous content causes EM signals to decay too quickly for such systems to be truly effective in monitoring corrosion and evaluating pipe thickness or metal loss in casing strings. So while corrosion resistance may have increased, there is now a potential information vacuum.

TGT, the market leader in through-barrier diagnostic systems, has developed a new multi-barrier integrity diagnostics system – EmPulse. The system quantitatively determines individual wall thickness in up to four concentric tubulars, ensuring long-term well performance in the most challenging high-chromium production environments.

The EmPulse system incorporates 'ultra-fast' sensor technology, three independent sensors, and 'time-domain' measurement techniques to capture EM signals rapidly and accurately in a wide range of pipe materials before the signals decay.

In three recent Middle East deployments – an operator witnessed 'yard test' in 28 per cent chrome pipe with built-in mechanical defects, and two live wells – the EmPulse system correctly identified man-made defects and quantitatively determined the individual tubular thickness.

This successful validation in high-chromium tubulars brings important reassurances for Middle East operators in protecting well system integrity – providing accurate corrosion information and addressing a crucial information gap.

The case of sustained annulus pressure [SAP]

Another major challenge to Middle East well system integrity is that of SAP – pressure in any well annulus that rebuilds when bled down.

Reasons for SAP can vary but are often due to weaknesses in the cement during completion; cement degradation due to thermal and pressure loading; leaking tubing connections or wellhead seals; and corrosion. According to a 2013 SPE webinar on wellbore integrity [Paul Hopmans], out of ~1.8 million wells worldwide, a staggering 35 per cent have SAP, with many Middle East fields facing varying levels.

Wells with SAP need to be carefully managed and production can be adversely affected or halted. SAP can also cause further damage to the well system, potentially resulting in the failure of the production casing or outer casing strings, and well blowouts.

While many operators are addressing SAP through new well designs and barriers, and better quality control over cementing – with existing wells they are having to rely on surface data – fluid sampling and bleed-off/build-up data, for example – to investigate the problem downhole.

There is also the challenge of being able to locate leaks and unwanted flowpaths behind multiple barriers, not clearly seen by conventional temperature and ordinary noise logs.

TGT's spectral diagnostics technology locates leaks and flowpaths throughout the well system by tracking fluid movement behind pipes within several casing strings.

Spectral diagnostics utilise high-fidelity downhole sound recording systems to capture the frequency and amplitude of acoustic energy generated by liquids or gas moving through integrity breaches and restrictions such as cement channels, faulty seals and casing leaks. When coupled with surface data, the information can narrow down the range of remedial options available, and target leak repairs.

Spectral diagnostics also harness fast, high-precision temperature measurements to locate integrity breaches throughout the well system. High-precision temperature sensors respond more quickly than conventional sensors to the localised thermal changes caused by integrity failures, complementing acoustic measurements by providing a visual confirmation of leaks and flowpaths.

While conventional production logging measurements typically assess only high-rate first-barrier failures – the high-fidelity recording, sensitivity and clarity of spectral diagnostics enables the tracking of even low-rate leaks at very early stages behind multiple barriers, enabling timely intervention and prolonging well life.

In the following example [figure 2], a water injector well experienced sustained B-annulus pressure, although the build-up rate did not exceed one bar a day – indicating a low-rate leak.

A cement bond survey indicated good cement bonding below X500m, and poor bonding above. Poor cement bonding is likely to provide flowpaths for fluid movement behind casing. Unfortunately, cement bond log indications of 'good bonding' don't guarantee annulus integrity. Flowpaths can exist that remain unnoticed by the cement bond log.

A survey utilising TGT's spectral diagnostics system was conducted and revealed fluid flow from the reservoir around X540m and channelling up the annulus through the 'good bonding' area.

The frequency spectrum pattern correlated with reservoir permeability and fluid-type profiles, suggesting gas being produced from these formations. The operator used the information to target a cement squeeze operation at the desired location in the well – restoring B-annulus integrity and eliminating the SAP.

Evolving challenges, new technologies

As Middle East operators continue to face well integrity challenges, gaining a deeper insight into both well and reservoir dynamics is vital. Advanced well diagnostics systems are now available to allow this to be achieved.

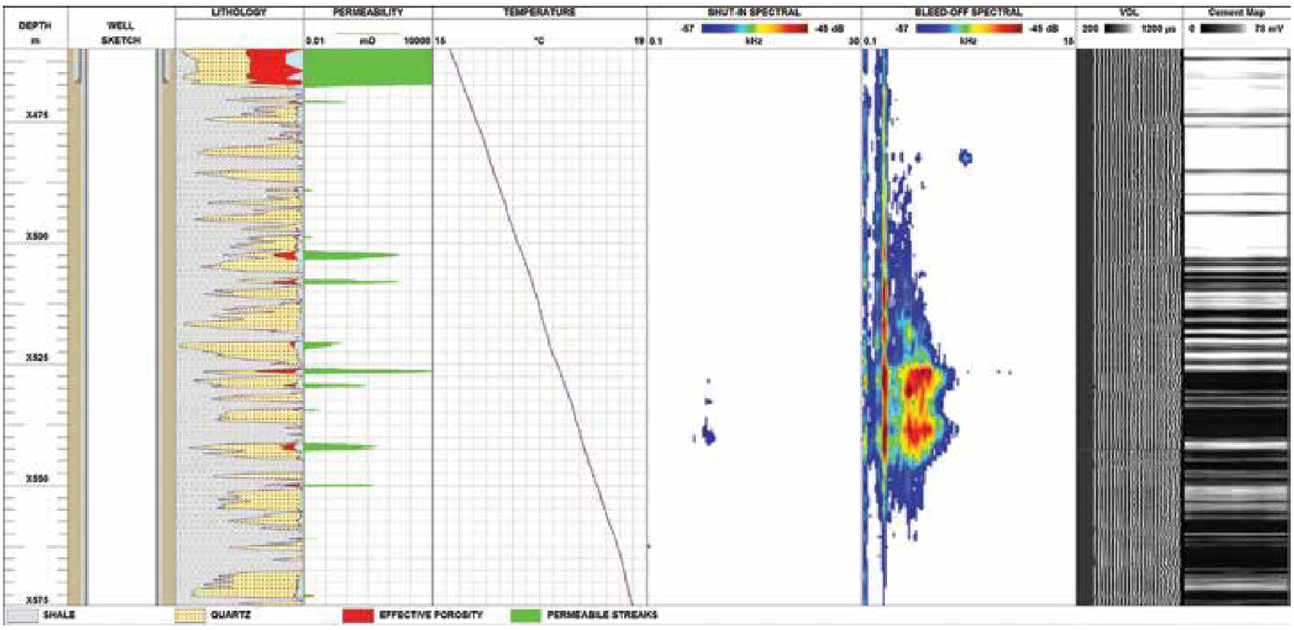

Figure 2—Spectral diagnostics survey revealing source of SAP behind casing at X540m where the cement map indicates 'good cement'.