Mature fields account for the vast majority of current global hydrocarbon production. With ageing fields and the requirements placed on them come well integrity challenges requiring monitoring, maintenance, and remediation. The global price of corrosion, leaks, cement channelling, gravel pack issues, and the associated costs reach billions, particularly with lost-production revenue; however, good pipe integrity helps ensure production and well stability throughout the life of the well. Because tubing and casing are integral links to production, it is vital to gather the best information regarding all pipe conditions for the structure of a well, and not just a few strings.

Well integrity issues commonly impact production and can be difficult to assess or predict. This has created a need in well integrity diagnostics for a through-tubing solution that effectively detects a leak’s flow anywhere in the well and accurately identifies its depth, radial location, and flow path. In addition, assessing pipe corrosion or corrosion rate through the entire well is important for effectively mitigating corrosion or planning an intervention. Accurate diagnostics are essential for keeping oil and gas projects on budget and producing. Operators benefit from precisely describing well integrity because more complete knowledge of pipe conditions facilitates improved interventions for long-term results, creates a viable monitoring plan, meets governmental regulations, and provides descriptive information for decision making.

A two-step solution
Halliburton offers a two-step solution for locating and describing well leaks and pipe corrosion. Together, the Acoustic Conformance Xaminer® (ACX™) and the Electromagnetic Pipe Xaminer® V (EPX™ V) services help identify a leak quickly and describe the extent of damage to the pipe, leading...
to an efficient solution to repair the problem. They also help identify other possible areas that can be treated at the same time. This combination is a valuable resource for addressing well integrity issues.

The ACX tool is used primarily for flow assurance, well integrity, and well leaks by mapping the flow in and around the wellbore, including between annuli and throughout the completion. The ACX tool measures acoustic energy with an array of highly sensitive sensors, allowing detailed information about the leak to be collected from several angles. These sensors use a beam-forming algorithm to define a leak’s radial distance and depth location in real time.

When corrosion is a problem, the EPX V pipe-inspection tool quantifies metal loss in one to five concentric strings of pipe in a wellbore – the first tool of its kind with this capability. The EPX V tool uses high-definition frequency (HDF) technology, which emits electromagnetic waves continuously into all well tubulars with no wellbore fluid influences. These waves are sent in multiple distinct frequencies that increase the tool’s performance and help determine metal loss and thickness of each pipe. Algorithms that calculate loss for each joint, total thickness, and overall condition define the magnitude of metal loss for each pipe.

Operators are now able to examine the entire well in one trip and quickly assess pipe condition, corrosion rates, and metal loss. This capability enables operators to obtain comprehensive information for monitoring programmes to help determine the best solution to address completion damage, in addition to reducing costs and preventing production loss.

The ACX and EPX V services can be used throughout the life of the well and on any kind of asset to help locate and address integrity concerns. If a well has corrosion issues, the problem is not likely isolated, and other areas of the well should be inspected. Combining information allows the mechanism of a leak to be further described and can reveal other potential issues, such as a 1 ft problem that is a potential 500 ft problem. Real time data reduces non-productive time, and ease of data interpretation minimises costs. The tools can detect through multiple strings and are combinable with other cased-hole services, reducing extra runs. A leak can be pinpointed within inches, and the data collected further describes the problem so the most efficient remediation can be made.

Environmental and regulatory issues
Well leaks and corrosion are a concern for environmental and regulatory issues. Well integrity left unchecked might lead to well loss or field production system issues, which raises more health, safety, and environmental concerns. For the well itself, it can add challenges for plug and abandonment operations. The ACX tool’s ongoing well monitoring can address leaks and integrity challenges before they become greater safety issues or before production is stopped or restricted. Tracking corrosion rates with the EPX V tool is useful in determining mitigation effectiveness and intervention planning.

The ACX and EPX V data combination provides a more complete look at the integrity problems within a well and what the engineer can be faced with when repairing it. The last thing an engineer wants to do is to repeat remediation because it is an unnecessary expense and does not sit well with the budget or leadership. If a leak occurs on a well because of corrosion, the odds are high that there are other areas of corrosion elsewhere. Gathering insight into well conditions is important.

For example, a well was indicating a leak in its outer layers; however, because of the leak’s location, it was not something that could be tolerated. According to diagnostic tools, primarily the ACX service, the leak was present in Annuli C. Temperature is typically always run and recommended in combination when diagnosing well integrity and is an excellent method for confirming other diagnostic tool measurements or what they reveal. It does not provide detail but, in general, should agree with what other diagnostic tools indicate; however, temperature measurements are hampered by the environment immediately surrounding it. As with every technology, temperature logging has its applications.

In this case, the ACX tool provided a detailed picture of where the flow was occurring. Because of the location, corrosion was
assumed to be the primary culprit; therefore, EPX data were also collected on the well. The well was in good shape; however, at the location of the leak, corrosion was revealed in a localised area, indicating a pinpoint entry for repairing the well. There were not several hundred feet of bad pipe, which is the best-case scenario for this leak type. Upon examining the rest of the well, two other areas suggested localised corrosion in the same string; however, the corrosion rate was not as high as the area with the leak. This is when a financially informed decision can be made for a workover on the well regarding whether the problem can be fixed now or later. Because of the information provided by the ACX and EPX technologies, a next-step conversation can occur with great confidence and a vigilant eye toward resources.

Some customers withstand leaks and corrosion on multiple wells. Leak and corrosion data proved highly beneficial for an operator who had a well experiencing an annulus B to annulus C pressure communication, which was similar to others previously identified by the ACX tool. Because the operator’s leak was impacting production and similar wells in the area experienced shallow surface-casing corrosion problems, the operator wished to know the extent of this potential problem to develop a remediation plan.

Halliburton proposed assessing the corrosion using the EPX V tool’s HDF technology, which is capable of logging the well in a single pass without needing additional services to assign metal loss per pipe string. Additionally, the 1 11/16 in. outside diameter allowed assessing the 9 ⅝ in. surface casing from within the 2 ⅞ in. tubing. The EPX V tool operates off mono-conductor wireline or in memory mode, allowing the operator flexibility to choose how to run it most efficiently. The section of the well in question was logged, and the results indicated a shallow metal loss anomaly. Subsequent surface diagnostics were performed that confirmed the anomaly’s shallow location.

Because the problem was confirmed near surface, a rigless external casing repair could be performed, which can save the cost and help prevent the potential risk associated with using a rig to cut and pull multiple strings of pipe. Looking ahead, the operator plans to continue using the EPX V tool in an effort to survey and prioritise wells for additional proactive corrosion monitoring and prevention. Proactive surveillance allows for optimised intervention timing and reduced well downtime. In the future, the EPX V and ACX diagnostic services can be run together from the beginning for this operator, saving time and money while providing a complete picture of any challenge.

Summary

The importance of mature fields cannot be underestimated in the current oil and gas industry because they continually provide much of the current resources to market. Well integrity is quickly becoming an area of focus in mature fields, and oilfield services that address challenges become increasingly more important. Ensuring the delivery of oil and gas to surface by means of integral mechanical well barriers is as important as tapping into or increasing additional reserves. The environmental effects of hydrocarbon production are also of greater concern than ever before, with increased regulation by government agencies and stewardship from operators. Many factors affect casing and cement integrity throughout the well life cycle. Fortunately, innovative technologies are meeting the challenge and providing superior data to allow operators to make informed decisions, monitor wells, plan interventions, and help ensure adherence to environmental regulations.