Coalbed methane (CBM) is a relatively young industry and is perhaps the most unconventional of the unconventional hydrocarbon industries. A defining characteristic of CBM development is that it requires low development cost to be profitable, which makes some classic oilfield approaches prohibitively expensive. Because of this, a number of innovative operators are applying unconventional approaches to this most unconventional resource.

Inflatable Packers International (IPI) of Perth, Western Australia, plays a leading role in supplying downhole equipment that is optimised for low-cost and innovative development strategies. IPI has an established track record as a supplier of equipment to what can be called the hydrotechnical market (the water well, mining and geotechnical sectors) and has successfully adapted its technology to the CBM industry. IPI’s philosophy is to provide systems that will work with existing standard equipment that maybe found on the drill site, in order to keep cost and complexity of specialist equipment to a minimum.

PERMEABILITY TESTING
Permeability testing for CBM development is done primarily to evaluate the methane potential of a coal seam for reserve evaluation or to assess the environmental impact of producing that coal seam. Permeability is important because the methane is released (or desorbed) when the coal seam is depressurised by means of dewatering. It is important to know the permeability characteristics of the coal during the early planning phase of a project to determine optimal well spacing, to anticipate pumping requirements and to evaluate produced water handling strategies.

Different coal seam characteristics and managerial philosophies have led to various approaches to permeability estimation. In areas where coal seam characteristics are well known due to coal mining exploration and development, such as in the Powder River Basin (PRB), there may be little or no preliminary testing at all. In most areas, however, the permeability and other coal characteristics must be determined by permeability testing before a preliminary evaluation of the resource can take place. The most common form of test has been the injection fall off test (IFO), where the coal seam is injected with water at high pressures followed by a “shut in” period in which the fall off in pressure is measured with electronic memory gauges. This type of testing has been popular in New Zealand and in India, but in different formats.

INDIA: CLASSIC IFO TESTING
The classic form of IFO test is common in India. For evaluation of some of the initial blocks, IPI were commissioned by one of India’s major CBM pioneers to manufacture a variable length straddle packer system that could be run on tubing with packer inflation/deflation, injection and shut in modes set by a vertically orientated setting tool, actuated by tubing movement. Known as the IPI CBM Tool, it rapidly became the standard for testing in India and is now owned and operated by several leading E&P companies and by service companies, catering for well sizes from NQ (3 in.) to 8.5 in. or larger.

The tool can carry several electronic memory gauges (EMG) and can be linked to the surface for real time monitoring of the testing process. The system can be run on coiled tubing or conventional tubing. The tubing is filled with water for packer inflation. This feature makes the system well suited for injection type tests and is quite simple to operate and maintain, as well as being competitively priced compared to oilfield tools.

The system is normally operated as a straddle system with inflatable packers set at the top and bottom of the coal seam. It is
capable of multiple sets in a single run. A defining characteristic of this type of testing is that it is done as a discrete testing phase once the well has been drilled to target depth. This form of testing very much suits an oilfield E&P approach, with a well testing specialist company coming in for the testing phase.

**NEW ZEALAND: SIMPLIFIED IFO TESTING**

In contrast, CBM exploration in New Zealand has developed by using slim hole technology originally designed for mineral mining and by adopting a simplified version of the IFO test. In mineral mining, permeability testing is often carried out using a single packer system deployed as part of a wireline coring system. Typical mineral mining wireline packer systems have traditionally been nitrogen gas inflated and are quite limited in terms of what depth and pressures they could work at.

In contrast, IPI has developed the Standard Wireline Packer System (SWiPS™), a hydraulically inflated packer system that is capable of 1000m+ operations with pressures up to 1500 psi. It targets the deep and remote minesite projects that are increasingly the norm in today’s large-scale hard mineral mining industry.

There was another immediate advantage to this format. Mineral mining coring systems provide a core sample of coal for lab testing purposes. As the ratio between the bit ID and the hole ID is about 65%, it is ideal for IPI’s packer technology. An industry standard and low cost coring sampling system can thus be coupled with an advanced inflatable packer system that could do the permeability tests that CBM E&P required. This could be subcontracted to a drilling company as one operation with minimal extra staff and equipment than that needed for mineral coring. This was appealing to low budget operations and especially where only a few test wells may be drilled in a remote location.

SWiPS can carry an EMG and can adapt quickly from single to straddle format as required; however, it lacks an integral shut in valve. To cope with this, New Zealanders developed a simplified form of IFO test that was done by shutting in at the surface. This approach, while less desirable than downhole shut in, is sufficient for a qualitative permeability estimate.

**PERMEABILITY TESTING IN AUSTRALIA**

While these two forms of testing were being developed, well
testing commenced and developed in what is now seen as the biggest CBM industry development: Queensland. Here IFO testing did not give results that were as predictive as could be gained by running the classic form of drill stem test (DST), in which a zone that has been isolated by packers is flowed by opening up a downhole valve to enable a flow into the drill rods that have been at least partly evacuated of well fluid. This form of test naturally suited testing systems that were initially developed for oilfield by North American companies. However, these tools are relatively expensive to operate, partially because the oilfield-style packer elements typically would last less than 10 tests. Seeing another niche for IPI technology, operators started to fit IPI packers on the North American systems. The operators found that they could get triple the number of tests, or more, using IPI technology.

As operators learned more about the effectiveness of IPI’s hydrotechnical equipment, they encouraged IPI to further develop the CBM Tool to compete with the oilfield tools. Firstly, the setting tool was redesigned to enable circulation to the annulus, such that the water level could be blown down for a DST using an air compressor. This has turned out to be a very viable alternative to the oilfield DST, although the requirement for a powerful air compressor to blow down the water does take away some of the cost advantages. Further, use of compressed air downhole is counter to accepted practice for oil and gas E&P, the global standards for which are often in force at several major Queensland CBM E&P companies, despite the exercise being carried out on what is fundamentally a water well.

The second fundamental development by IPI has been a balanced piston. It had been found that the CBM DST shut in valve could cause a pressure spike when actuated, which at an extreme could influence the results. The balanced piston has near zero displacement and is a timely introduction as a third test type has come into vogue in Queensland and parts of Southeast Asia. The dynamic fracture initiation test (DFIT) is basically a much higher-pressure version of IFO that can involve several thousand psi injection tests at quite high volumes. That can result in quite high frictional loss and not all tool types can cope with these pressures and flow rates. The IPI tools (now renamed the ST series if they have the balanced piston), however, are fundamentally suited to injection type tests.

A FLEXIBLE SOLUTION

In its most recent tool, the STX series, IPI has married the best of its developments for the mineral coring industry and the unconventional gas industry by incorporating a down-hole shut-in valve in a slimhole tool that can be run either on wireline or on tubing. The 60 mm tool is the same diameter as the most common SWIPS size (HQ). HQ coring system rods are capable of over 3000 psi, which is matched by the STX-60’s 3000 psi capable standard packer elements. With a four-stage setting tool function, it is capable of performing all test types in common use. It can also be readily used in a PQ (122.6 mm) hole, either within a HQ coring system or, with minimum adaption, within a PQ core barrel system. In addition it can be run on tubing like the rest of the ST range, with a cross over to 86 mm or even 127 mm packers, in either single or straddle format. Finally, an attractive feature for the Southeast Asian market is that the circulation facility can help prevent a string getting “bogged” while in poor hole conditions. Initial deployments to Colombia and Mozambique, indicate that is should prove popular with unconventional gas clients.

Companies looking to succeed in the unconventional gas markets will benefit by finding unconventional approaches to exploration programs. The use of mineral coring rigs and IPI’s hydrotechnical tools is a good example of applying unconventional, but appropriate technology to significantly decrease the cost of exploration.