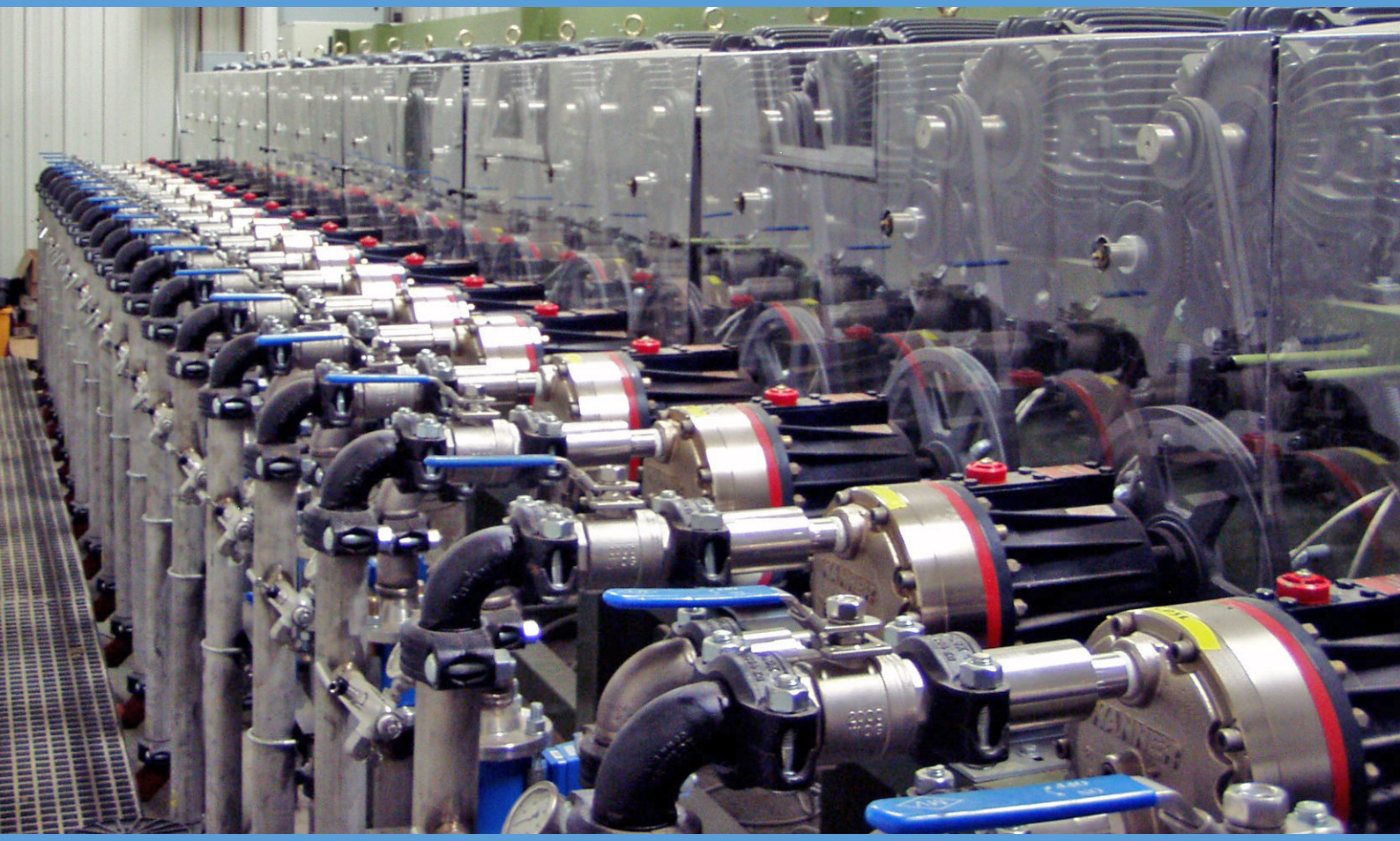
Paul Davis, Wanner International, UK, takes a look at the advances made in the field of seal-less pump technology.



THE IMPORTANCE OF PUMPING

In July 2011 the operator of a saltwater disposal (SWD) well in South Bossier Parish, Louisiana, USA, was looking forward to the replacement of a saltwater injection pump. There was nothing special about it, just a standard triplex plunger pump. But the pump taking its place was a different matter. It was the first model in the 'T' series; a new category of higher capacity Hydra-Cell pumps developed by Wanner Engineering.

What lay behind the well operator's anticipation was the prospect of no longer having to deal with worn packings – the T8045 was the first 'triplex' pump to have no dynamic seals or packings in its design.

Since almost every oil and gas company in the world has to deal with produced water, the installation at South Bossier Parish has some historic interest as the first SWD application for a T Series pump. Its success was quickly confirmed by the installation of a second pump one week later. The installer was the jet pump manufacturer JJ Tech.

In developing the T Series, the Hydra-Cell pump concept was extended into higher flow and pressure capacities, where in any oilfield application up to 170 l/min. and 310 bar it competes with various types of pump, and most directly with conventional triplex plunger pumps.

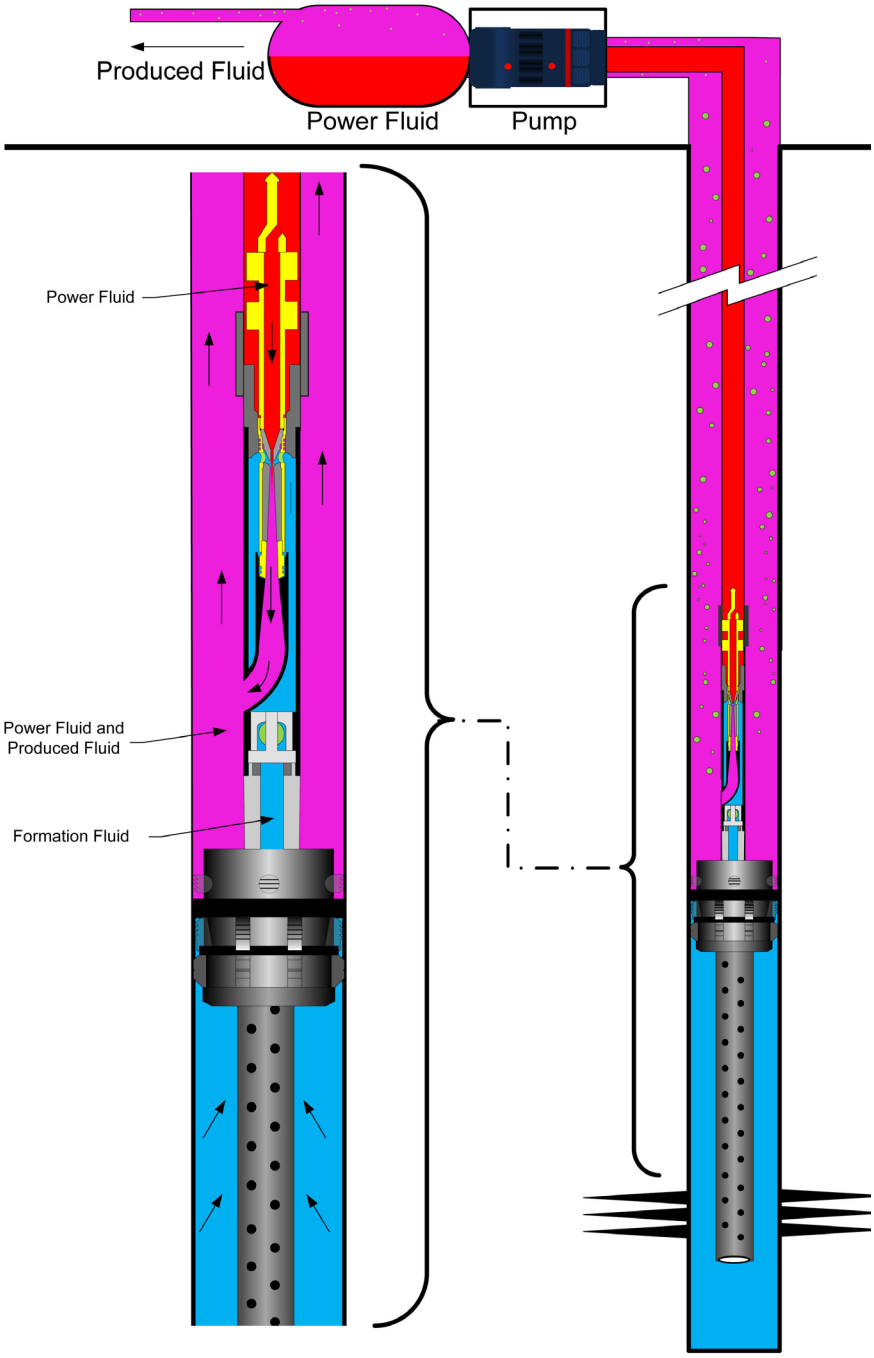


Figure 1. *Well diagram with JJ Tech jet pump.*

Figure 2. *JJ Tech saltwater disposal system, with T8045 sealless pump.*

In this context it should be remembered that 'triplex' pumps, in the narrow definition of positive-displacement pumps configured with three reciprocating plungers, have for many years been widely regarded in the oil and gas industry as the type best fitted to handle some of the sector's more challenging pumping tasks.

In drilling and well service operations, triplex plunger pumps are traditionally the type most frequently thought of whenever the application involves factors such as high pressures, deep wells, continuous duty, or liquids that some types of pump cannot handle without damage. Typical oilfield applications for triplex plunger pumps, and also the Hydra-Cell, include water flooding, enhanced oil recovery (EOR), saltwater disposal and, from the surface, delivering power fluid to a downhole jet pump in artificial lift systems.

Claims about a pump's liquids handling ability are perhaps best treated with caution. They are sometimes relative, or need qualifying – most obviously when the liquid pumped contains abrasive particles. This applies to plunger pumps, piston, pumps, gear pumps, centrifugal pumps and any other type of pump that is reliant on a dynamic sealing arrangement such as plunger packing, or incorporates closely meshing metal contact surfaces. The manufacturer's own service and repair manual may not always support a salesman's claim.

Challenging applications

The T Series was originally conceived to handle severe pumping applications in the oil and gas industry. More specifically it was prompted by the need of jet pump manufacturer JJ Tech to find a suitable surface pump with a capacity, performance and reliability compatible with its own downhole jet pump – a patented design developed to produce large volumes of subsurface formation fluids with inclusions of moderate to high solid content. A feature of the design is easy retrieval of the pump from the hole, using surface valves with the surface pump to reverse fluid circulation. No wire line, pulling unit or workover rig is needed.

The surface pump in this lift system, originally a plunger pump was used, delivers 'power fluid' at pressure to the jet pump deep in the well. The jet pump's venturi accelerates the power fluid, pulling in produced fluid and driving the combined fluid (typically a harsh mix of water, particulate debris, oil and gas) to the surface, where the power fluid is separated and re-injected.

JJ Tech was however concerned that over the long term, the plunger pump, being seal-reliant, would not be the perfect partner for the jet pump.

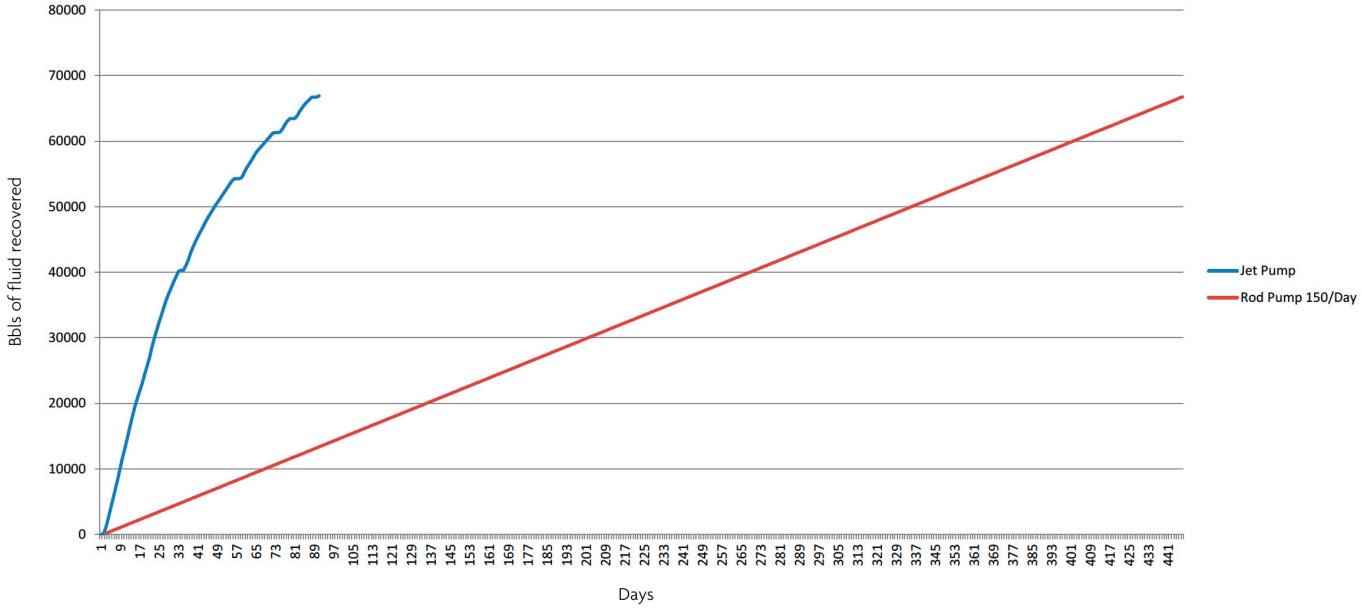


Figure 3. *Oil recovery speed: jet pump versus rod pump in frac-flowback.*

The company was already a convert to Hydra-Cell technology, having teamed its jet pump successfully on applications in relatively shallow wells with a 5-diaphragm D35 model, (flow capacity up to 37 gpm at 1200 psi).

For example, in May 2008 the Philberg Oil Co. in Tuscaloosa, Alabama had a deviated well (2846 ft pump depth) working on a rod pump system. The rods frequently cut the tubing string, causing lost production, as well as requiring monthly workovers to pull and replace damaged segments – adding further costs. The rod pump was replaced by a JJ Tech Ultra-Flo lift system with downhole jet pump and the compact D35 mounted on a small skid at the surface, to deliver power fluid at high pressure.

Joint effort

Since the two manufacturers, jet pump and surface pump, had a mutual interest in extending the Hydra-Cell range into areas of higher flows and pressures, the way was open for further collaboration on the development and testing of the T Series.

These pumps are now active in jet pump installations in North America, the North Sea and the Middle East. Current applications include artificial lift, gas well dewatering (GWD) and frac-flowback. All utilise a downhole jet pump in combination with a Hydra-Cell T8045 or T8030 surface pump, according to the flows and pressures required.

Frac-flowback, the recovery of fluid used to stimulate oil or gas production in the high-pressure hydraulic fracturing process, can be accelerated by JJ Tech's Ultra-Flo system with a number of advantages. High volumes of fluid (up to 4000 bpd) can be produced, while production rates are easily controlled. Rapid fluid recovery helps prevent formation swelling. Gas can be brought to the market immediately. No back-pressure is put on the formation. At an installation in the Permian Basin in the southern US, using the T8045 as surface pump, the operator removed 70 000 bbls of fluid in 90 days – an output that with rod pumping at 150 bpd would have taken 15 months. Also recovered and sold were 40 million ft^3 of gas valued at US$ 100 000 (US$ 2.49/thousand ft^3). Total estimated value of production over the 90 days was US$ 2 176 480.

Gas well dewatering removes water build-up in the natural gas well – a result of slower gas flow as the stream weakens through time and fails to carry water droplets to the surface. The Hydra-Cell T8030, rated at 5000 psi and 905 bpd, is well suited to GWD concentric-string completions, where the narrower fluid conduits require higher pressures to overcome fluid friction. An early application was at a gas well in Oklahoma.

In early 2012, JJ Tech installed a permanent production system for a gas well operator in East Texas. The surface configuration of most conventional production systems spreads out the components to separate locations. Here, the compact design of the T8045 made it possible to mount the whole surface installation on an 8 ft x 16 ft skid. Additionally, as the jet pump is approximately half the length of other systems, it can be installed downhole more compactly.

By October 2012, JJ Tech had installed another five Ultra-Flo systems for this customer.

Refining the design

Triplex plunger pumps and piston pumps, though built by a number of different manufacturers, have more in common with each other than with other types of pump. The Hydra-Cell is a distinct type. T Series pumps, similar in external appearance to conventional triplex plunger pumps, are very different internally.

The T8045, and its sister model T8030, are derived from the same unique technology as other Hydra-Cell pumps. It was conceived in the early 1970s by William F. Wanner Snr., inventor of the first seal-less Hydra-Cell pump.

The aim was to build a reliable pump of simple design that could work at pressure, handle liquids with solid particles and be easy to maintain. Wearing or damaged seals have always been the most common cause of high maintenance and pump failure. The new pump would dispense with dynamic seals altogether.

The central concept is valid today. With no dynamic seals in the pump, problems of seal wear are automatically eliminated. Pumping action is achieved by hydraulic actuation of multiple diaphragms manifolded together in a single pump head.

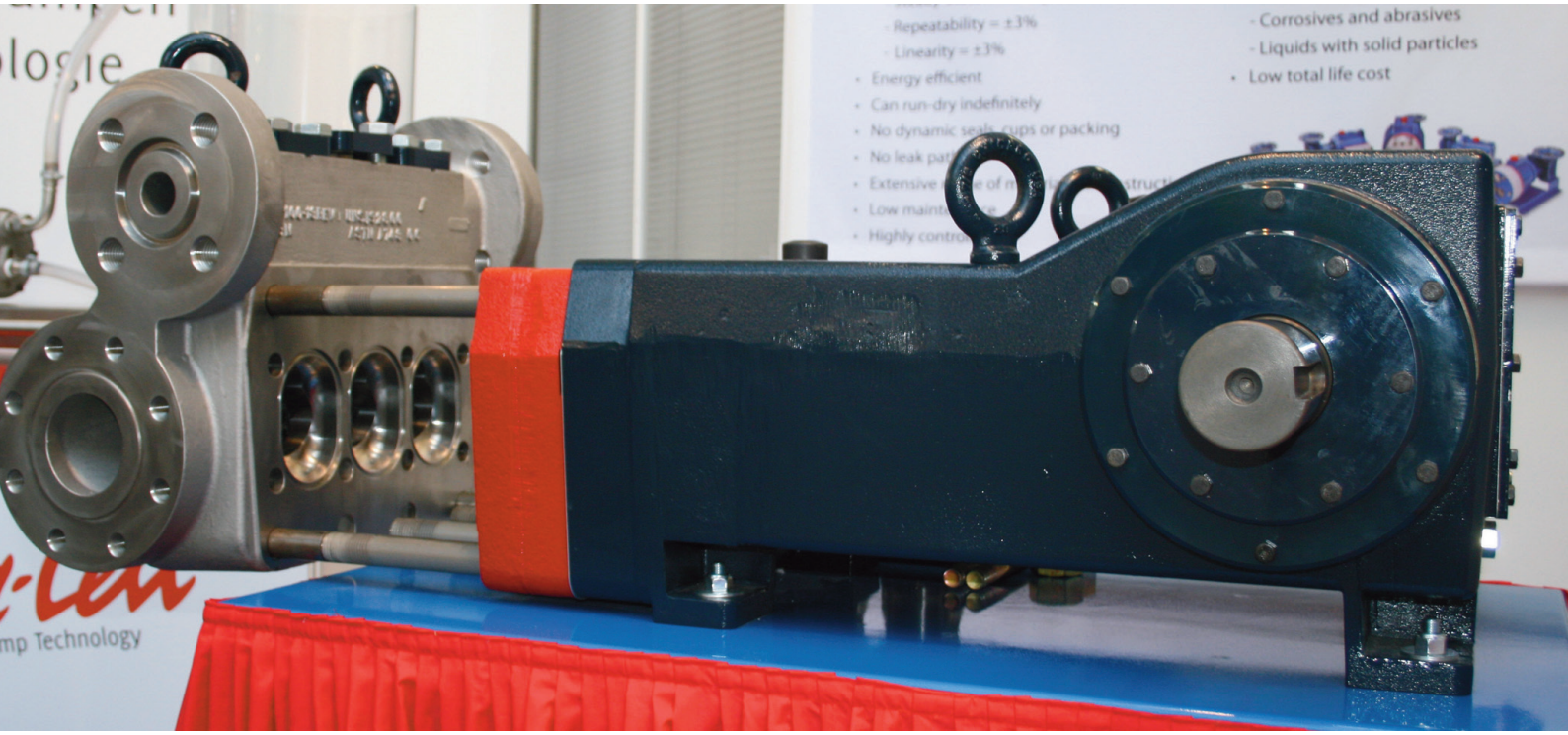


Figure 4. *In-situ maintenance: stud extenders take weight of manifold, allowing T Series pump diaphragms to be replaced without moving the pump.*

Hydraulically balanced, enabling them to operate at any pressure level without stress, the diaphragms totally isolate the liquid end of the pump from the hydraulic (drive) end. The pump can handle a wide range of liquids, from slurries to thin non-lubricants and including caustics, acids, abrasives and those containing particles. Wetted parts – diaphragms, pump head, valves - are available in a variety of materials to suit the application.

The first Hydra-Cell pump was the D10, max flow 10 gpm at 1000 psi. Development over the years has seen new models of pumps developed: the D10 pump of today for example incorporates a diaphragm position control technology, known as Kel-Cell, which prevents damage to the pump if it draws a vacuum. If an inlet filter is blocked, a feeder vessel runs dry or someone by mistake shuts a valve in the supply line, the pump will continue to operate indefinitely – pumping only air but suffering no damage.

Case studies

Romgas, the state-owned gas company in Romania, was first made familiar with Hydra-Cell pumps through their reliable record in pumping TEG in 12 new gas-drying plants built for the gas company by a German engineering contractor The contractor, EMS, had preferred the Hydra-Cell over previously-used piston pumps on that application. Romgas subsequently chose Hydra-Cell to replace piston/plunger pumps for a different task – disposal of water containing particles and absorbed gases by re-injecting it into the gas well.

When enhanced oil recovery (EOR) system specialist Nalco FabTech designed and installed a 21 pump polymer injection facility for a Wyoming oilfield it was looking beyond the established plunger-type pumps in general use for polymer injection, and turning to Hydra-Cell H25 diaphragm pumps. Six years later the pumps were still running 24 hours a day and the company had put in additional Hydra-Cell pumps to extend the facility. Each pump is individually and simply controlled to match varying conditions in its own well. It can operate anywhere between 1 l/min. and 69 l/min. at pressures up to 70 bar.

Proper handling of the polymer solution is imperative to avoid degradation through pumps and pipes. Its sensitivity makes it difficult to dissolve and pump. The Hydra-Cell design, with its smooth, low-pulse low-shear pumping action minimises internal friction, reducing heat input into the system and helping to ensure that the injected liquid reaches its target in effective condition.

Hydra-Cell pumps have often been used in conjunction with larger units – for example with centrifugal pumps for seal-flushing, or with large piston/plunger pumps for pressure boosting. In one case reported from a US oilfield piston/plunger pumps were delivering salt water direct to a disposal well, but pressure losses in the two mile high-pressure pipeline were slowing down the operation and hampering production. By installing a Hydra-Cell D15 as a booster pump at the header serving individual wells, the operator was able to boost injection pressure and increase flow to required levels. Inlet pressure at the booster pump was 300 psi – deemed too high for piston/plunger pumps. Flow rate on the booster system was 15 GPM and discharge pressure 870 psi.

Conclusion

Offshore or land based, there can be few operations in the oilfield more important than pumping, but the technologies employed tend to be mature – and maturity does not always equate with maximum efficiency or reliability. In pump selection, following industry custom may not turn out to be the wisest or most cost-effective course. Awareness of options and an open mind are valuable tools for the pump specifier! OT