Leak-free pumping is always desirable, sometimes essential - but the pump must also satisfy other criteria of performance and life cycle cost

Waste not, leak not

In an ideal world industrial pumps would not leak. In the real world there are good reasons why a majority of pumps do leak, and by design are intended to do so.

These are pumps that rely on dynamic sealing (usually now a mechanical seal) at the drive shaft to contain the liquid being pumped and keep it separate from the pump's drive mechanism. Leakage by intent is confined to a very few drops of liquid per hour. The purpose of this thin liquid film is to lubricate and cool the close-tolerance mating faces of the basic seal elements, one attached to the housing, the other rotating with the shaft.

If the seals dry out, frictional heat can threaten rapid seal wear, leading if not remedied to pump failure. Independent lubrication is one way of evading trouble, but on grounds of simplicity and cost the solution favoured by most pump manufacturers is to use the pumped liquid itself as lubricant.

With notable exceptions, the great majority of pumps incorporate this arrangement in one form or another. Seal-reliant types include positive displacement pumps such as piston, plunger, gear, vane, lobe and screw pumps – as well as centrifugal pumps, which on their own handle well over half of the world's industrial pump applications.

If these pumps did not generally and in most conditions perform perfectly well and to the satisfaction of their users they would have passed into history. Yet total reliance on mechanical sealing is a potential weakness. Operational requirements, pressure, heat and especially the varied demands posed by exposure to the liquids pumped can attack dynamic seals and render them ineffective. Typically difficult liquids for a seal-reliant pump can include corrosives, thin liquids (many of which are poor lubricants) and any liquid that carries abrasive solids.

Seal failure or excessive wear inevitably result in leaks if action is not taken swiftly and the consequences might range, according to circumstances, from costly to life threatening. Even when no dangerous emissions are involved, pump leaks may cause environmental problems. These leaks are also associated with loss of performance and waste of energy, along with product loss, either directly or through downtime.

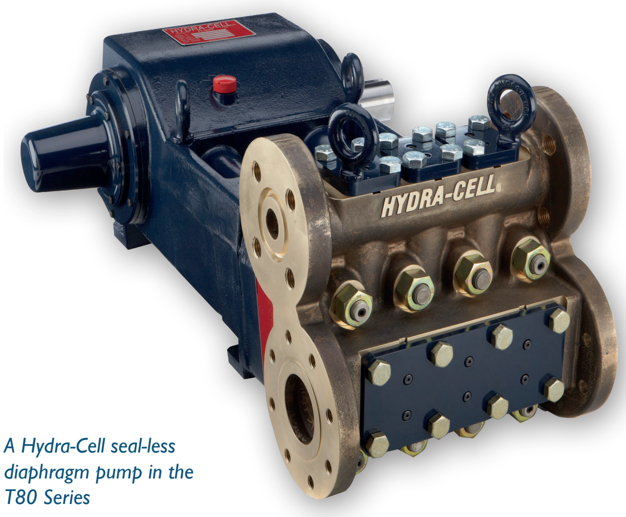
Leak-free injection of produced water at Texas oil well (T8045)

These are all factors in the increasing use of seal-less pumps. No seals, no seal leaks. Less need for constant vigilance and frequent maintenance. Zero leakage is ideal and, in some circumstances, essential.

Two types of pump for which that claim is made are the canned motor pump and the magnetic drive pump. Each utilises a familiar technology adapted with the primary or sole objective of making the pump leak-free. Each avoids the threat of shaft seal failure by breaking physical connection between drive shaft and impeller.

The canned motor pump is a centrifugal pump in which the impeller is directly attached to the motor rotor. A can separates the wetted rotor from the motor stator.

In the 'mag-drive' centrifugal pump two sets of magnets are encapsulated respectively in an outer drive housing (attached to



A Hydra-Cell seal-less diaphragm pump in the T80 Series an electric motor) and an inner driven housing (attached to the pump's impeller). There is no physical connection between magnets. Torque is transferred from motor shaft to impeller via magnetic fields. The technology has also been applied to gear pumps and other types.

However, the mag drive and the canned motor are by no means the only prominent candidates.

In evaluating leak-free pumps for purchase an obvious point should not be forgotten. A leak-free pump is still a pump. It must do its job, satisfy technical parameters, perform consistently and reliably. If pump types are compared, are there pointers for TCO, LCC or MTBF? Taking the wider view means taking account of the overall features, limitations and strengths of the pumps under consideration.

Apart from leak avoidance, do the canned motor or the mag drive alter the underlying strengths or limitations of the technologies to which they have been applied? It is a question worth asking, because in certain other pumps that merit the description leak-free the feature is built into their basic technology.

Methyl formate. Hydra-Cell pump and hose pump

Pumps in action

Early in 2013 a Texas oil well operator, Brammer Petroleum, replaced a leak-prone triplex plunger pump on a brine injection application with a new pump – one of the latest 80hp seal-less Hydra-Cell diaphragm pumps manufactured by Wanner Engineering.

At this location, produced water containing sand and salt is re-injected into the ground via four injection wells to shift oil from the formation to six production wells. Working flows and pressures range up to 1,500 bbl/day and 1550 psi.

The seal-less pump has worked from the outset on the same demanding 23 hour daily duty as its plunger-type predecessor, but with minimal maintenance and no sign of wear, leaks or loss of performance.

The oil company had used some of Wanner's smaller diaphragm pumps for 20 years and liked the fact that they do not use seals or packings. Capacity had been the chief limitation. The first one installed by Brammer had a maximum flow rate of 20 gpm, and use was restricted to smaller wells, producing up to 500 bbl/day.

A larger pump (a five-diaphragm model) extended possibilities and both models continue to handle produced salt water reliably with no leaks.

The company's experience with seal-reliant triplex plunger pumps on re-injection duty had been less positive – ranging from continuous small leaks of grass-killing water to broken plungers, high repair costs and pumps breaking down, sometimes as often as once a month.

Other leak-free types that should be mentioned are peristaltic pumps, commonly known as hose pumps, and hydraulically actuated single-diaphragm pumps. The latter is the traditional metering pump of the chemical industries – with individual models available in a wide range of sizes and flow capacities. Flow rate is varied by stroke adjustment. Multi-head options with a common drive shaft are offered. This type of pump can handle almost any liquid and operate at low or high pressures.

The Hydra-Cell pump

The Hydra-Cell pump shares certain features with single-diaphragm models, such as hydraulically balanced diaphragms, enabling the pump to operate without stress throughout its full pressure range. In common with these traditional pumps there are no seals or packings to wear and leak.

In almost all other respects the Hydra-Cell pump is radically different. The design is unique, incorporating multiple diaphragms within a single compact head – making delivery smooth and pulsation minimal. Bulk, footprint, weight, purchase cost and operating expenses including repairs, spares and power requirement are dramatically lower than those of a traditional diaphragm pump of equivalent performance. Construction features such as stroke adjustment are not needed. Flow is easily and accurately varied by changing motor speed electronically via inverter.

Diesel sampling – liquid is extracted and re-injected into a pipeline at pressure

The peristaltic pump has a roller or shoe that progressively squeezes a replaceable flexible hose or tube. The action moves liquid along the tube, drawing in more liquid as it progresses. The pump can handle a wide range of product including corrosives and some liquids carrying solids. It is broadly suited to low pressure operation at pressures ranging up to 15 bar.

Of all leak-free pumps mentioned, the Hydra-Cell has perhaps the widest range of application. In situations where zero leakage is obligatory, or those in which leak-free is just one priority, it has often shown itself to be best option in meeting all the system parameters. Further examples from the company's files are briefly noted below.

The design concept originated in the 1970s with William F. Wanner, inventor, engineer and co-founder of Wanner Engineering, still a privately controlled company and still the sole manufacturer. His first pump was able to deliver a wide variety of liquids, hot or cold, thin or viscous, clean or dirty, over a flow range up to 30l/min and 70 bar max pressure. It could handle abrasives and solid particles. It proved to be an exceptionally reliable pump, simply built, giving sustained performanca and needing little maintenance.

The advantages of a seal-less pump when handling produced water, with sand or salt abrasive/corrosive content are quickly apparent. Less obvious perhaps is that they also apply in situations where the liquid is clean, most severely when its temperature rises. Water, of all liquids the most commonly pumped, is many times more corrosive at 90°C than it is at 20°C.

Other features common to all Hydra-Cell seal-less pumps include high efficiency (+85%), gentle handling of product, dry running and more, but it is the combined effect of all its features that underpins its versatility, often enabling it to replace alternatives or be selected against them.

Case studies

A mining company in the US chose Hydra-Cell G25 pumps for an environmentally sensitive operation that involved safe and reliable injection of cyanide concentrate to form a weak solution subsequently delivered into a a high volume water stream. Seal failures in pumps originally used had caused potentially dangeropus emissions, expensive repairs and production losses. Leak-free seal-less design of the Hydra-Cell pumps, combined with availability of chemically-resistant component options and accurate dosing were among the advantages cited by the customer.

A cement producer in the Czech Republic was using vane pumps to feed benzine waste to burner nozzles as fuel. The pumps wore out at the rate of two per year. Containing dirt and carbon particles, the liquid was also non-lubricating and toxic – a potential hazard unless the system could be made leak-proof.

Replacing the vane pumps, a Hydra-Cell G35 handled the product safely and satisfied the performance requirement of 60l/min at 40 bar (16 GPM at 580 psi). Chosen pump head material was nickel-plated cast iron.

A major manufacturer of formic acid, based in Indonesia, initially used a hose pump to transfer methyl formate from another plant – but sometimes the liquid is dirty and contains particles. The hose pump, from a well-known manufacturer, could not handle the contaminated liquid. Reliability became a serious issue – to the extent that natural rubber hoses, each costing more than €190, had to be replaced every 14 days.

When the hose pump was taken out of service and replaced with a Hydra-Cell G25 the problem was solved. Eight months later the G25 was still operating without interruption.

Canned motor pumps installed at the Quidong plant of China Petroleum to transfer gas condensate were continually breaking down. Reliant on the process fluid to lubricate rotor, wear rings and impeller bearings, the pumps could not satisfactorily handle a process liquid that contained water, sand particles and corrosive chloride ions.

Vulnerable components wore prematurely. Failures were frequent, maintenance costs were high. Hydra-Cell G25 and G35 pumps, both in ATEX format, replaced the canned motor units and ran trouble-free. Twelve months later they were still operating smoothly, with no maintenance needed and no problems to report.

For more information:
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Hydra-Cell G25 replaced canned motor pump on transfer of gas condensate