Evaluating Seal-Less Pump Technology for Demanding Industrial Applications

HOW SLIDING VANE, INTERNAL GEAR AND ECCENTRIC DISC PUMPS USE CONTAINMENT DESIGNS TO REDUCE LEAKAGE RISKS, IMPROVE PRODUCT CONTAINMENT AND SUPPORT SAFER CHEMICAL PROCESSING OPERATIONS.

by Ron Crouch



The most obvious shortcomings of mechanically sealed pumps in chemical processing are the catastrophic failures that can occur when the seals fail. In these instances, valuable raw materials and end products are irretrievably lost, while the safety of plant personnel and the environment is put at risk.

Introduction

To the average person, many of the raw materials that are commonly used in the manufacture of chemicals can resemble either a steaming bowl of alphabet soup – KOH, NaOH, HCl and HF, for example – or a bad Scrabble rack – toluene and xylene, monomers and polymers, for instance. However, those who make a living manufacturing such chemical-based compounds as caustics, acids, solvents and polymers know that these valuable chemicals are pivotal to the production process, but can also be extremely dangerous and harmful to site personnel and the environment if not handled properly.

This is a constant concern for manufacturers as hazardous chemical compounds are used in a large number of industries and products, such as:

- Adhesives
- Biofuels
- Petroleum Additives
- Polyurethane Foam
- Molten Sulfur
- Pulp and Paper
- Food Processing
- Resins
- Soap and Detergents
- Paint and Coatings
- Lube Oils and Greases
- Petrochemicals
- Herbicides and Pesticides
- Silicates

In addition to being widely used and potentially dangerous or hazardous if mishandled, many chemical compounds are also extremely expensive. If a leak were to occur during the handling or transfer of these products, large costs would be incurred by the operator due not only to the loss of raw materials, but also for cleanup and potential environmental remediation. All of these factors combine to make the full containment of dangerous chemicals a front-of-mind concern for facility operators.

Crucial pieces of equipment that are utilized during the manufacture and handling of dangerous chemicals are the pumps that either introduce raw materials into the production process or transfer end products for packaging, storage or shipping to end users. Mechanically sealed pumps are commonly used for these transfer activities, but this white paper will illustrate how seal-less pump technologies can often be the more effective choice when full containment of dangerous and valuable chemicals is an absolute must.

The Challenge

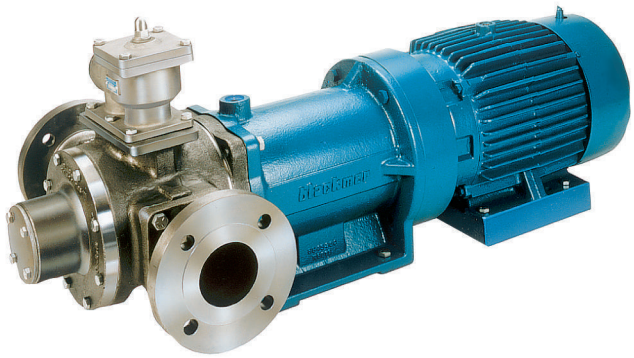
When handling dangerous chemicals, there are four main areas of concern for manufacturers:

- **Safety:** Ensuring that site personnel, surrounding communities and the environment are not harmed
- **Product Containment:** When dangerous or hazardous products are fully contained and not allowed to leak, valuable raw materials and products are not lost to the environment, improving safety overall
- **Maintenance:** Mechanical shaft-seal failures can be a significant source of pump downtime, resulting in repair costs and interruptions to production. Excessive maintenance costs generally are accumulated in two

forms – the need to constantly repair, rebuild or replace underperforming pumps or components, and in the downtime that brings production runs to a grinding halt

- **Operating costs:** An overlooked drag on the bottom line can be in the form of costs associated with seal-flush water due to water contamination into the process and the cost of the water

The most common pump technologies that are used in the manufacture and handling of dangerous chemicals include diaphragm, sliding vane, lobe, progressive cavity,



Seal-less sliding vane pumps feature a magnetic coupling consisting of samarium-cobalt magnets and a unique bearing and head design that allows a small quantity of pumpage to circulate through the containment can, which minimizes temperature rise and maximizes bearing life.

centrifugal and gear. Many conventional rotating-shaft pump designs rely on packing or mechanical seals to limit fluid leakage along the pump shaft. The two most common types of seals, packing and mechanical, are used in many hazardous-chemical applications, but they both have their own potential shortcomings:

- **Packing Rings:** This method utilizes braided packing material that includes a set of formed rings that are wrapped around the pump shaft and held in place by an adjustable gland that has been designed to control shaft leakage. A small amount of leakage is needed for lubrication and cooling. Packing has been widely used in a variety of industries (such as in resin and paint and coatings), but should not be generally considered a best practice for hazardous chemicals.
- **Mechanical Seals:** These seals come in two general variations: single and double. Single mechanical seals can usually adequately address the problem of fluid leakage, but when used with liquids of higher viscosity, the product drag can distort the seal or cause it to break away from the shaft completely. Single mechanical seals may not provide sufficient containment for certain hazardous or volatile fluids. Double mechanical seals, when used with appropriate support systems, can provide greater containment but introduce additional equipment, maintenance and operating costs.

While any of the various types of seals can perform admirably for long periods of time, they will eventually need maintenance or need to be replaced before major shaft leakage can occur. Replacing the seals, not only after they fail but also as a form of preventative maintenance, is costly.

The cost of a leak to a manufacturer includes the loss of valuable raw materials or finished products, downtime in production, and the costs and potential penalties associated with the chemical cleanup. Leaks of hazardous materials that reach the outside environment can be subject to fines and remediation costs from the U.S. Environmental Protection Agency (EPA), as well as other local and state regulatory agencies. Additionally, other countries have their own sets of regulations, which can often be more stringent than those in the U.S. Spilled hazardous materials also pose safety risks for site personnel and cleanup crews, which raises liability issues.

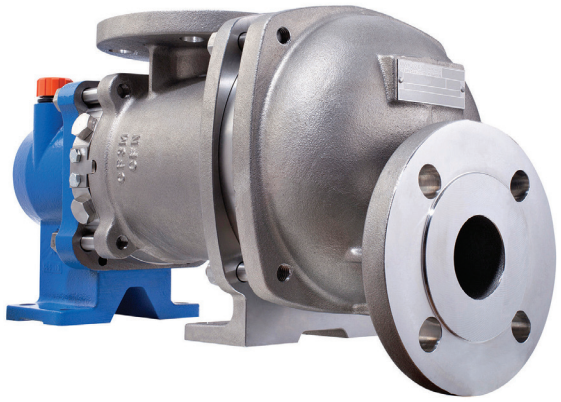
The Solution

While sealed pumps can perform admirably in the manufacture, transfer and handling of dangerous chemicals and other hazardous materials, the shortcomings that are inherent in their sealed design can make them insufficient for the job. Fortunately for the operators of chemical-manufacturing facilities, there is an alternative technology that can help eliminate some of the major concerns associated with achieving full containment: seal-less sliding vane, internal gear and eccentric disc pumps.

Let's take a look at the advantages of a few specific seal-less pumping technologies:



Next-generation seal-less internal gear pumps feature only one fluid chamber, which not only enhances product containment, but eliminates product entrapment, especially when transferring high-viscosity liquids.



Seal-less eccentric disc pumps feature no seals, packing, couplings or magnets, which translates to full product containment coupled with the added benefit of optimized product-recovery rates.

Sliding Vane

Seal-less sliding vane pumps constructed of corrosion-resistant stainless steel generally feature a magnetic coupling consisting of samarium-cobalt magnets and a unique bearing and head design that allows a small quantity of the pumpage to circulate through the containment can and onto the bearing surfaces. This positive flow of fluid minimizes temperature rise during operation, which helps maximize bearing life.

Replaceable 316 stainless-steel end discs allow easy rebuilding of the pumping chamber to like-new condition without having to remove the pump from the piping. Additionally, carbon-graphite sleeve bearings help ensure no metal-to-metal contact during operation.

Operationally, seal-less sliding vane pumps offer the same advantages as their sealed cousins: volumetric consistency, self-priming and limited dry-run capability, drain plugs that allow easy draining and easy replacement of worn vanes.

Internal Gear

Technological advancements in internal gear pump design and operation now offer to the market models that have only one fluid chamber. This method of construction removes the adapter plate that is a staple of traditional two-chamber magnetically coupled internal gear pumps, which eliminates product entrapment concerns, especially when transferring high-viscosity liquids. One-chamber operation is achieved through a between-the-bearings design that places the magnets directly on the pump rotor, resulting in a simpler flow path and full leak-free product containment.

Some seal-less internal gear pump models are also constructed of as few as seven primary components, which helps contribute to an estimated 50% reduction in maintenance costs when compared to sealed pumps. There are also seal-less internal gear pump brands and models that are interchangeable with 95% of competitive sealed or packed-gear pump brands, making time-saving drop-in replacement a reality.

Eccentric Disc

Seal-less eccentric disc pump models feature no mechanical seals, packing, couplings – or even magnets, with the shaft sealed instead by a unique double stainless-steel bellows. Operationally, seal-less eccentric disc pumps can still offer self-priming, dry-run and low-shear operation, very high suction and discharge pressures, the ability to pump both low- and high-viscosity liquids and clean-in-place/sanitize-in-place (CIP/SIP) capability.

Additionally, by virtue of the unique eccentric disc operating principle that allows them to pump air, seal-less eccentric disc pumps can recover up to 90% or more of residual product from suction lines and typically 60% to 80% from discharge lines, depending on system configuration and operating conditions.

This enhanced product-recovery capability can result in thousands of dollars in cost savings annually from the retrieval of still useable raw materials and saleable end products.

These varying types of seal-less pump technologies check all of the right boxes when it comes to overcoming the four major challenges in handling dangerous chemicals or hazardous materials: optimized Safety; full Product Containment; reduced Maintenance; and streamlined Operating Costs.

Conclusion

Sealed pumps have been performing sufficiently in chemical-manufacturing operations for many years. However, operators who are looking for a better alternative should look to upgrade their facilities with seal-less pumps. These types of pumps will reduce leakage events and improve containment of dangerous or hazardous materials.

By reducing maintenance associated with conventional shaft seals, seal-less pumps can help lower total operating costs over the equipment's service life.

For chemical processors, seal-less pump technology offers a practical way to improve product containment, reduce leakage risks and address maintenance costs while supporting safer, more reliable operations.

About the Author

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