Ancillary products

Mechanical seal benefits spelt out

Sealing systems help maintain pump efficiency, reliability, energy consumption, water usage and emission control. This article argues that sealing performance can be improved in most centrifugal pump applications by upgrading from traditional compression packing to mechanical seal technology.

The environmental performance of products and processes in all industrial sectors is increasingly coming under critical inspection, with sustainability, conservation of natural resources and reduced environmental contamination directly influencing the design and selection of equipment. There are many industrial processes that can be addressed to improve sustainability and minimize environmental impact, while at the same time maintaining or reducing operating costs. Implementing energy-efficient and environmentally-friendly processes and technologies should be embraced as a priority at the component, process and system levels.

Included in these processes is mission-critical rotating equipment, and specifically centrifugal pumps, which represent a significant proportion of the equipment found in most industrial manufacturing and processing operations. One of the vital components of a centrifugal pump is the seal around the rotating shaft which passes through a stationary pressure casing or housing. The seal contains the liquid or gas from escaping to the environment.

Pump packing seal exhibiting excessive leakage to the environment.

Sealing systems are vital in maintaining pump efficiency, reliability, energy consumption, water usage and control of emissions to the environment. These factors can materially facilitate a process plant in achieving total life-cycle-cost-reduction and sustainability objectives. In support of achieving these objectives, sealing performance can be considerably improved in most centrifugal pump applications by upgrading from traditional compression packing to mechanical seal technology.

Compression packing

When sealing a centrifugal pump, the objective is to allow the rotating shaft to enter the wet area of the pump, without allowing large volumes of pressurized fluid to escape. The discharge pressure of the pump will force fluid back behind the impeller, where it attempts to exit by way of the rotating drive shaft. To minimize this leakage there needs to be a seal between the shaft and the pump housing that can contain the pressure of the process being pumped, and also withstand the friction caused by the shaft rotating.

Pump packing seal exhibiting excessive leakage to the environment.

Compression packing has traditionally been used to seal centrifugal pumps, going back well over 100 years. Also referred to as gland packing, it is a braided, rope-like, and lubricated material that is packed around the shaft in rings, physically stuffing the gap between the shaft and the pump housing, within a stuffing box.

For compression packing to work, some leakage must be maintained to lubricate and cool the packing material. So the packing rings allow for an adjustable, close-clearance leak path parallel to the axis of the shaft. But as the packing ages through use, some of the lubricant that is embedded into the packing is lost, reducing the volume of the packing rings. The pressure that is squeezing the rings together is also reduced, increasing the amount of leakage.

Maintenance requirements

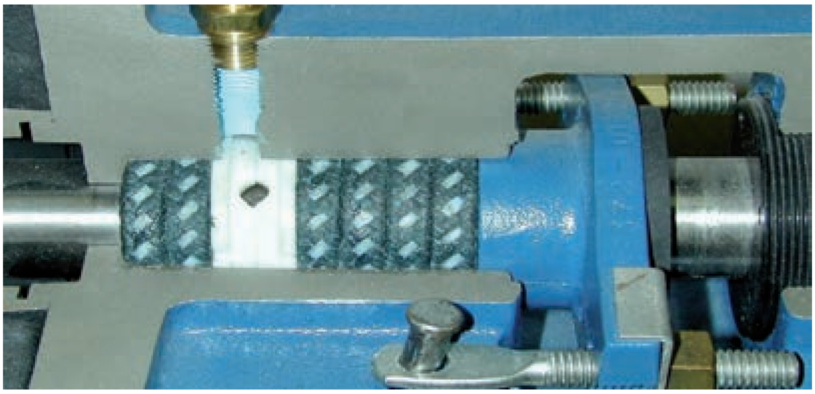
Periodic adjustment of the packing follower will bring the pressure back into specification, and control the excess leakage, but increasingly, that maintenance is not always being performed at required intervals, or adjusted correctly. As the number of centrifugal pumps that incorporate the use of compression packing has decreased, the training and understanding of packing maintenance has waned. Consequently, under-tightening and over-tightening of the packing rings is a prevalent and growing misapplication of maintenance of centrifugal pumps, with critical consequences to both water consumption and energy draw.

Under-tightening results in too much leakage. Already, when properly adjusted, packing leakage can amount to gallons of liquid leaked per minute. This can be either aqueous solutions comprised of varied benign or caustic chemical compositions, or particles in suspension or slurry, depending on what is being processed. The heavier the suspension or slurry content is in the liquid being pumped, the more water is needed to get packing to work reliably. Typically, a clean external flush is piped into the stuffing box through a lantern ring, which keeps the packing lubricated, cool and flushed of abrasives and chemicals.

Normally, some portion of the leakage is continually being released into the atmosphere. Under-tightening of the packing rings and use of external flushes increase this atmospheric release proportionately, along with the potential for environmental impact. Friction is always present in centrifugal pumps with compression packing, due to the large surface area of the packing rings in contact with the shaft. Over-tightening of the packing rings restricts leakage flow, increases friction between the packing and the shaft, and generates excessive heat which degrades the packing. The increased friction also wears the shaft prematurely.

But from an energy consumption perspective, that additional friction of the packing gripping the shaft creates increased drag, requiring more drive power to turn the shaft. It is that drag which creates an additional, and significant, parasitic energy draw. The importance of this friction-induced energy draw is critical to assessing the energy efficiency of compression packing.

But this is not the only factor influencing energy usage with compression packing. When examining the energy draw component of a total life-cycle-cost analysis related to the use of compression packing in centrifugal



Packing seal chamber.

pumps, other factors need to be considered. Such as: a) the external flush that is piped into the stuffing box – this pressurized water or fluid needs to be moved from a source location to the packing.

This requires a pump that draws electricity; b) in applications like mining, where compression packing is more commonly used, water added via the packing flush to maintain a clean environment around the packing needs to be later taken out. The removal of this water requires energy, typically through boiling; and, c) the pump heat soak – energy transferred from the hot metal of the pump to the fluid within the packing chamber.

These energy draws are not typically measured directly. Instead, current and voltage fluctuations utilized by the pump motor are assessed under varied operating conditions to determine how much power is being consumed by parasitic influences, which enables packing energy deficiencies to be identified.

Compression alternative

An alternate to compression packing is the mechanical seal, which resolves many of the sustainability and environmental-impact issues inherent in compression packing. These mechanical seals require a much lower water and energy demand, and have substantially reduced leakage, making them much more efficient at containing volatile or hazardous fluids, aqueous solutions and slurry suspensions. In addition, mechanical seals require no maintenance, once installed.

A mechanical seal is comprised of a stationary primary element which is fixed within the pump housing, and a rotating mating element fixed to the shaft. Precisely machined, these two components are pressed together by a flexible load element, meeting at a wear face, while the extreme tolerance precisions between the two elements minimize leakage. The wear faces are supported on an extremely thin lubricating film, typically 0.25 microns (9.8 microinches) in thickness. Available in a wide variety of types, arrangements and materials, mechanical seals are found in the majority of centrifugal pumps today.

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Mechanical seals require very little flush water needed to be injected into the seal chamber. Compression packing used in abrasive pumping applications requires significant volumes of water to be injected into the stuffing box. A mechanical seal in the same service requires only a small fraction of this water volume. These seals create an extremely restrictive leak path perpendicular to the axis of the shaft, between the two sliding seal faces. This results in almost no leakage to the atmosphere.

The amount of power required to drive a mechanical seal is up to 80 percent less when compared to compression packing, primarily because the seal faces have less frictional energy losses due to the extremely precise mating between the stationary and rotating elements. Additional energy reduction requirements take the form of the reduced need for flush water to be pumped into the seal, which is required with compression packing.

Dual seals

Designed to ensure maximum sealing safety, dual mechanical seals are typically defined as a single assembly that contains a pair of seals. A cavity is formed between the two seals within the assembly that is filled with a barrier or buffer fluid that separates the pumped liquid from the atmosphere and environment. Dual mechanical seals allow for near complete control over the seal operating environment and the fluid film lubricating the seal faces. They provide maximum elimination of leakage of the fluid being handled in centrifugal pumps.

Efforts made toward improving sustainability in manufacturing processes, whether by reduced water and energy use, or by eliminating the discharge of harmful fluids and gases, not only provide a benefit to the environment by reducing environmental impact, but also a benefit to manufacturers by reducing operational costs.

Mechanical seals in centrifugal pumps, and particularly dual mechanical seals, are well-suited to reduce or eliminate volatile or hazardous fluids, and their harmful vapors from escaping into the environment. They should be specified as the standard sealing solution, particularly when the pumped fluids present a safety, health, or environmental hazard. ●

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