

Beyond Seal-less: Leak-Free Pumps Come Of Age

CRITICAL DESIGN IMPROVEMENTS ENABLE ENVIROGEAR® TO DELIVER
ON THE PROMISE OF SEAL-LESS PUMP TECHNOLOGY

By Dale Evers



Introduction

Twenty years ago, the managers of a wide range of manufacturing and liquid-storage facilities would not have been incorrect if they thought that the industry was about to enter "The Age of the Seal-less Pump." With stricter federal emissions regulations set to be introduced in 1992, this would have been welcome news for those in the petroleum refining, petrochemical, gas processing and chemical industries where the use of hazardous/toxic materials or other pollutants was prevalent. Faced with tighter control guidelines for these types of emissions, plant and storage-facility operators needed a pump technology that could deliver the environmentally sensitive leak-free operation they demanded, while at the same time addressing maintenance and cost concerns.

Extensive documentation existed to support the thesis that seal-less pump technology was the answer in these applications. For example, in June 1990, Vista Strategies, Inc., a management-consulting firm, produced a report for a leading manufacturer of industrial gear drives, pumps and compressors that predicted, among other things, that:

- The Best Available Control Technology (BACT) for most refining, petrochemical and chemical plants will be seal-less pumps.
- The chemical industry is moving to use seal-less pumps at a faster rate than the petroleum industry.
- The seal-less market will be served two-thirds by magnetic-drive units and one-third by canned-motor units.
- The long-term answer to the new federal regulations will be seal-less pumps.

And, perhaps most significantly:

- Seal-less pumps will take an increased percentage of the market – probably 25% by 1995 and 50% by 2000.

A year earlier, a report titled "An Overview of BACT Guidelines For Centrifugal Pumps" was prepared by the South Coast (California) Air Quality Management District which noted the No. 1 BACT in terms of efficiency in controlling emissions in liquid-handling applications was seal-less pump technology, which was "becoming increasingly important, especially in the handling of toxic and hazardous fluids."

Looking back, we know now that 1990 did not signal the beginning of the golden age of seal-less pumps. The simple fact was that the technology – as it was designed and constructed at the time – wasn't reliable enough, with too many instances of failures that were brought about by bearing and load deficiencies that led to seal and leakage issues. These deficiencies created an operational stigma that many manufacturers of seal-less pumps are still attempting to overcome today.

But, after all that time, there now exists an innovative seal-less pump technology available that eliminates the bearing and load concerns that were affecting the performance of traditional seal-less designs. This technology has the capability to create a new category of seal-less gear pump that not only eliminates leakage concerns that can compromise safety for both plant personnel and the environmental, but also allows the operator to move all types of liquids, from the thin to the extremely viscous, and the hazardous to the benign.

This white paper will show how a fresh, clean-sheet approach to the conundrums inherent in traditional seal-less pump design were confronted and led to the creation of the EnviroGear® line of seal-less gear pumps. In short, EnviroGear pumps take product sealing to a new level of reliability while eliminating the unacceptably high ownership, maintenance and environmental costs – as well as the reputational taint – that have dogged past seal-less pump designs.

The Challenge

The leakage that occurs in traditional mechanically sealed pumps results in two types of prohibitive costs for plant operators: maintenance and environmental.

According to The Hydraulic Institute, as much as 40% to 50% of the cost of owning a pump is spent after the pump is bought, due to maintenance issues. The leading causes of high maintenance in conventionally sealed pumps includes the maintenance associated with mechanical seal replacement and the premature wear of the bushings and close-fitting metal parts due to insufficient support of the pumping elements. There is also an environmental cost of leakage in terms of cleanup and potential local, state or federal fines that may need to be paid in extreme cases – as well as the often-incalculable cost that bad press can result in.

The main point is that leaks cost money. It costs money to replace the raw materials that are lost. It costs money to replace the finished goods that are damaged. It costs

money to pay a firm to clean up the spill. It costs money to dispose of the cleanup. It costs money in potential slip-and-fall hazards. It costs money to pay environmental-compliance fines and fees. And it costs money in lowered worker morale, or the need to replace workers who may choose to seek employment elsewhere.

As mentioned, any pump design that is deemed to be “seal-less” needs to overcome the stigma that has been attached to the technology for more than two decades. In fact, while the reports cited above were trumpeting the use of seal-less pumps, efforts began almost immediately to discredit the technology's effectiveness and reliability when handling hazardous or toxic materials.

“There is a new, innovative seal-less pump technology now available that eliminates the bearing and load concerns that were affecting the performance of traditional seal-less designs.”

A report entitled “Meeting Emission Regulations with Mechanical Seals” released in April 1990 by the Seals Technical Committee of the Society of Tribologists and Lubrication Engineers (STLE) stated that “eliminating seals in pumps is not the solution to emission controls.” The standards committee included seven leading seal manufacturing companies working in conjunction with chemical company clients. The report went on to say “seal-less pumps seem like the perfect solution but rely on bearings being lubricated by the product being pumped. Thus, bearing problems result from converting to seal-less pumps.” The seal manufacturers effectively removed themselves as the weak link and focused on the perceived, and sometime real, bearing issues.

The report listed a number of perceived problems that were present when relying on the product being pumped for lubrication, including: the oftentimes poor lubricity of the pumped product; high instances of costly downtime for in-shop repairs; and the elevated chance that leaks will still occur, which exposes plant personnel and the environment to the pumpage. As pump manufacturers rushed their seal-less offerings to market, an overzealous sales force misapplied or over-applied their product. Initial failures, most common among high-speed centrifugal manufacturers lent credibility to the seal manufacturer's warnings. End-users became cautious; those burned would hesitate to consider seal-less technology again.

Then, most damningly, the report concluded: “Obviously, there is questionable, if any, benefit (of using seal-less pumps) to the end-user who is genuinely concerned with the environment and his personnel.”

Times Have Changed (as have Seal-less pumps)

Traditionally, seal-less gear pumps are designed with a cantilevered load where a large rotor gear is attached to the end of the pump shaft. As hydraulic force is applied to the rotor during pump operation extra pressure is put on the shaft and bearings. This pressure can lead to shaft deflection and increased bearing wear, which in turn results in more rotor-to-casing or rotor-to-head contact wear. The result is reduced pressure and flow rate.

Secondly, traditional seal-less gear pumps feature two fluid chambers – a hydraulic chamber where the gears work and a second chamber for the mag-drive coupling unit – that are joined together by a bracket, which also serves as a barrier between the two chambers. This complicated design requires that a portion of the material being pumped through the hydraulic chamber must be used to cool the magnets in the other chamber. These requirements result in a long, complicated pump with elongated, narrow flow paths and the need for more parts which makes the pump more expensive and difficult to maintain – while limiting the viscosity of the liquids that can be pumped, as well as the types of solids that can be handled.

The Solution

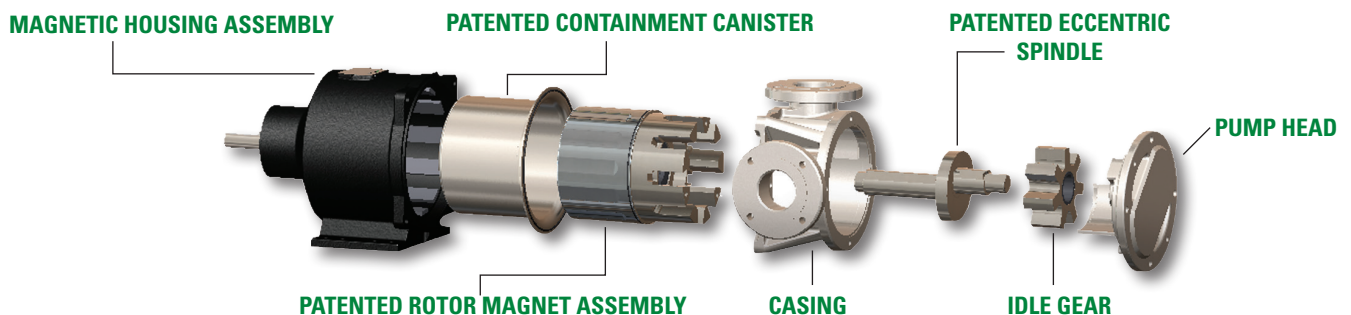
The approach to finding an ultimate solution to the seal-less pump quandary had to remove the word “seal-less” from the development process. When looking to create a gear pump that is affordable, controls leaks, and reduces maintenance costs and environmental concerns, the first step is to identify the areas where seal-less pumps fall short and look to improve on them. As mentioned, the No. 1 area where traditional seal-less pump operation is compromised is the bearings and how they interact with – and are affected by – the pump’s cantilever load. The second step is to find a superior replacement for the

two-fluid-chamber design that complicated the pump’s operation and limited its fluid-handling range.

Taking these main concerns into account, and approaching the design process with an open mind, the result is the EnviroGear® pump. The EnviroGear pump line is seal-less, not because the designers and engineers felt that it needed to be, but because its design enhancements led them to the conclusion that it would operate most effectively as a seal-less pump.

The EnviroGear pump also features two design enhancements to overcome long-time challenges of excessive bearing wear and a fluid chamber design that complicates operation and limits product range. These enhancements are:

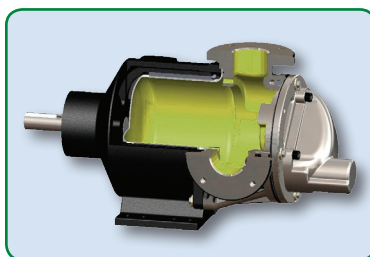
- **Between-the-Bearing Support System:** As opposed to the performance-robbing, one-sided support found in cantilevered-load design that exists in traditional seal-less pumps, the EnviroGear® pump supports the rotor and idler gears at three locations through the creation and incorporation of:
 - A patented **Eccentric Spindle** that is supported in the head, the crescent location and the back of the containment canister, eliminating much of the effects of cantilever load. In tests where 200 psi of pressure was applied to the rotor, there was only 0.005" of shaft deflection in the EnviroGear pump, compared to 0.056" of shaft deflection in a traditional seal-less pump, giving the EnviroGear 11 times less shaft deflection.
 - Larger diameter materials that provide more rigid support for less shaft deflection and bearing wear. For example, a traditional 3-inch seal-less pump will have a shaft that is 1⅞" in diameter; the diameter of the EnviroGear eccentric spindle is 2".
 - Large, long radial bushings that support the entire length of the rotating element, which spreads out the hydraulic forces and allows the bushings to last longer. The EnviroGear bushings are also made of



Designed with only seven primary parts.

premium-grade carbon graphite that will last up to eight times longer than more common bushing materials.

- **One-Fluid-Chamber Design:** As noted earlier, traditional seal-less pump design features two fluid chambers that are separated by a bracket; this design creates operational difficulties while limiting the types of fluids that can be handled. The EnviroGear design has only one fluid chamber with the pump's magnets placed on the back of the rotor and close-coupled, or "piggy-backed," on the rotor gear. This design gives the pump a much shorter, simpler flow path. It also allows the pump to easily handle viscosities in the 20,000 to 30,000 cP range, and as high as 50,000



The one-fluid-chamber design provides enhanced reliability and fluid safety.

cP, while still maintaining the ability to run thin liquids like caustics and various solvents. These redesigned pumps can also pump liquids and slurries that contain solids.

A third feature that the EnviroGear offers is dimensional interchangeability. EnviroGear pumps have been designed to be interchangeable with 95% of the other gear pumps that are currently available in the market. This means that a plant can be running a traditional sealed pump in the morning, have it pulled out in the afternoon and drop an EnviroGear pump into the footprint while reusing the same piping, gear box, motor and base plate, all while receiving the same hydraulic performance as what the previous pump was providing.

While the EnviroGear pump is designed to eliminate all of the operational concerns found in old-style seal-less gear pumps, its simple design – which consists of only seven primary parts: a magnet housing, containment canister, casing, rotor magnet assembly, eccentric spindle, idler gear and head – greatly reduces maintenance and environmental costs.



EnviroGear Internal Gear Pump.

Conclusion

In the end, the design of EnviroGear Seal-less Gear Pumps makes it not a traditional seal-less pump, but, rather, an engineered solution for environmentally conscious fluid-handling that lowers maintenance costs and eliminates environmental costs. The result is a new genus of seal-less gear pumps, one that does away with the operational shortcomings that helped stigmatize past seal-less pump designs while remaining cost-effective for the end-user. EnviroGear Seal-less Gear Pumps truly are the Best Available Control Technology on the market today for a wide variety of industries and fluid types, and truly deliver on the promise that mag-drive seal-less pumps seemed prepared to offer the fluid-handling industry more than 20 years ago.

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