Advanced Bearing Materials for Process Lubricated Systems

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In high-pressure reverse osmosis service, a high efficiency multistage pump solution and an advanced variable speed single-stage pump solution designed for continuous service needed a highly efficient and robust bearing solution that would deliver the lowest total life cycle cost.

Pump manufacturers in a variety of industries are increasingly asked to deliver more with less; they need to handle increased loads with improved system efficiency but reduce envelope, environmental impact and total system cost. As an added challenge, many of these applications are running in low viscosity process fluids. Such applications include chemical processing, mine-dewatering, seawater lift, subsea booster, water injection and desalination pumps.

Process lubricated applications require bearing solutions that can meet (or exceed) the load expectations of oil-lubricated systems while resisting corrosion and swelling, and operating under boundary lubrication conditions. The traditional solution to meet these requirements had been stainless steel pads running against a collar with a graphite insert or ferrobestos pads running against a hard interface; however, ferrobestos is no longer acceptable due to its asbestos content.

As an alternative, Waukesha Bearings, an operating company of Dover Corporation, has developed and validated solid polymer bearing technology to address the many challenges inherent in process lubricated applications. Solid polymer components offer the high load capability and low friction of graphite/stainless steel systems, the wear resistance of ferrobestos and temperature limits double that of standard Babbitt-lined bearings (250 deg C, 482 deg F). Critical to many applications, these components are also resistant to corrosion and capable of embedding particulate (such as salt or dirt) from within the closed system.

A solid polymer, tilting pad thrust bearing is capable of supporting loads up to 10 MPa at typical pump operating speeds. This bearing is engineered to accommodate lubrication by a variety of low viscosity fluids, including water, toluene, mono-ethylene glycol and hexane. The technology was released in 2007 after several years of development and field testing. Since that time, the bearings have been successfully integrated into numerous applications, including those running directly on pumped seawater like swash-plate pumps and high-pressure centrifugal pumps supplying water to reverse osmosis membranes in desalination plants.

Original equipment manufacturers (OEM) and end users of these products have noted benefits from the ability to use process fluids as a lubricant; one such benefit has been the ability to reduce the size, and subsequently the total cost, of the equipment through the elimination of separate oil lubricating systems and associated seals.

Pump Engineering, Inc., an Energy Recovery Inc. company, designs and manufactures high efficiency pumps and energy recovery hydraulic turbochargers for reverse osmosis systems. The company recognized the benefits of using process lubricated bearings and has designed their proprietary pumps to include this technology.

One pump model, a variable speed single-stage pump designed for seawater desalination, has a design point at a capacity of 5,700 gpm at a total developed head of 1,107 feet at 3,600 rpm. Solid polymer bearing technology allowed operation at high loads and very thin films, reducing thrust bearing power losses that can dramatically impact the pump's overall efficiency. Throughout the development process, the pump achieved efficiencies in the mid to high 80s. Efficiency levels approaching 90 percent are anticipated as the product line is expanded. The high load carrying capability of the bearing solution eliminated the need for a thrust balancing system (traditionally an industry standard), reducing design complexity

Solid polymer thrust bearings are engineered with temperature capabilities beyond 250 deg C and surface properties allowing for continuous high-load, thin-film operation.

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and areas of maintenance and potential failure.

Another pump model developed from the same manufacturer for RO service that benefitted from this bearing design is a high-efficiency, multistage reverse osmosis pump also designed for seawater desalination; it can deliver flows from 100 to 5,000 gpm at pressures up to 1,200 psi, and can also be used in cogeneration, pressure boosting, irrigation and boiler feed water applications. This efficient multistage reverse osmosis pump is designed for in-field hydraulic retrofit if operating conditions change. The bearings are designed with a margin of safety in operating loads and temperatures to allow field retrofit without the need for a bearing change.

These pump applications are ideally suited for solid polymer bearing technology. They combine the challenges of hydrodynamic bearing design with the application of advanced polymer materials to deliver optimized performance across a wide range of operating conditions. OEMs are realizing the performance benefit of thrust bearings operating on thinner hydrodynamic films, whether in water, process fluids or oil. Thinner films at optimized temperatures deliver substantially lower power losses within the bearing system, improving the overall efficiency of the rotating machine.

The partnership between the bearing and pump manufacturer led to an exclusive agreement covering desalination applications and has been beneficial for both companies throughout the development of RO pump product lines. Working together, these companies are looking for additional product applications to use the solid polymer bearing technology.

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