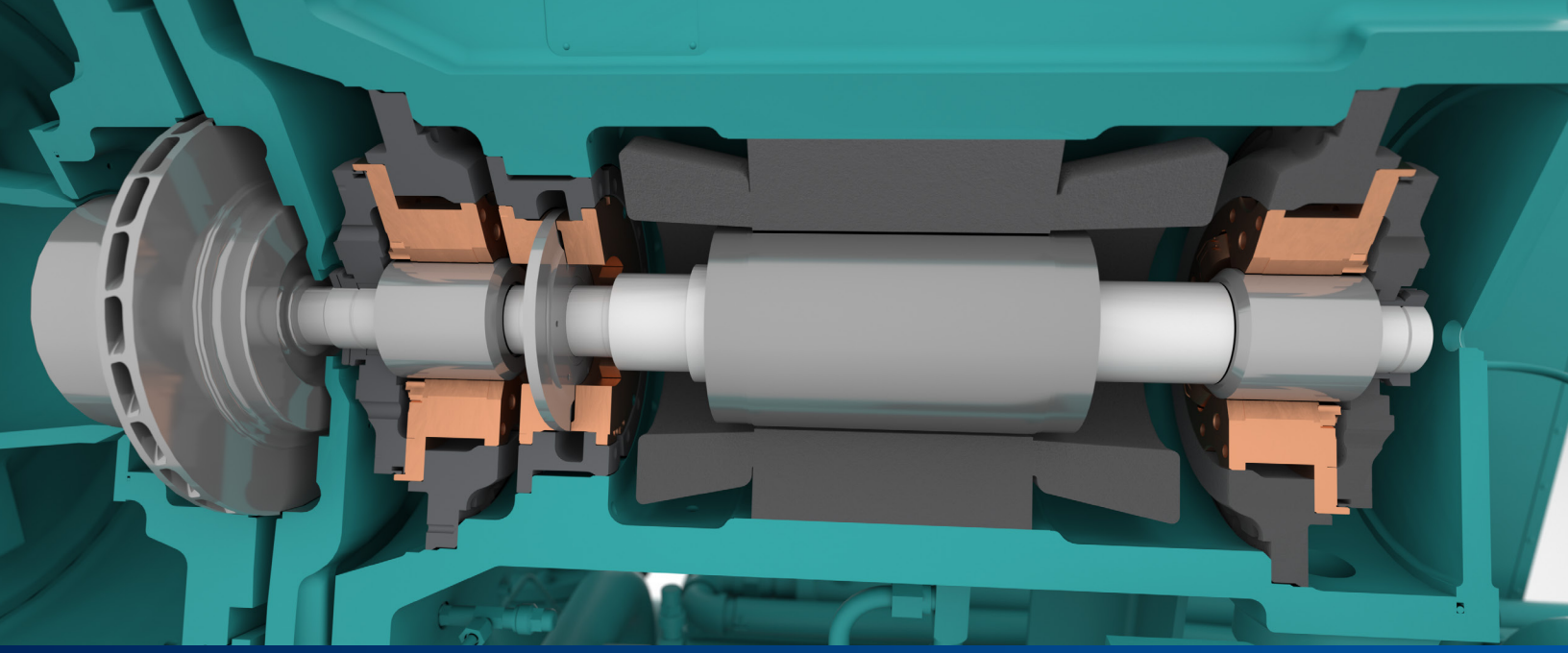
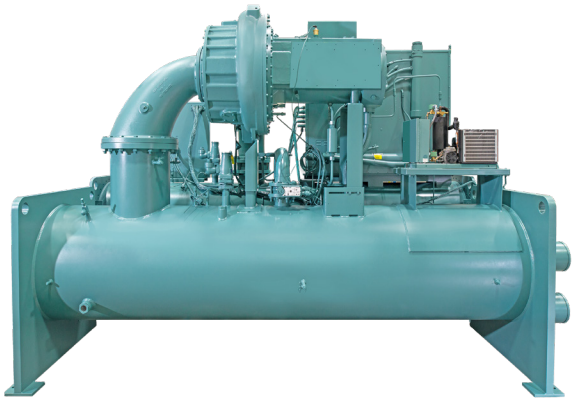


Make the Right Choice with Confidence

Not all oil-free centrifugal chillers are created equal

When designing and selecting a chiller, technology choices like compressor bearings can have a huge impact on performance, reliability and maintenance.



A decade ago, most centrifugal chillers utilized oil-lubricated bearings. Today, there are more options available, and with those choices has come an increased level of confusion in the market. For example, the phrases "oil-free" and "lubrication-free" are often used interchangeably to describe alternatives to oil-lubricated bearings, although they represent two very different technologies that can lead to dramatically different outcomes.

This paper is designed to offer clarity, putting building and business professionals on the path to making a more informed choice.

The Baseline Difference: An Evolving Level of Technological Sophistication

Think about how drastically telephone technology has evolved over the past 30 years. So, too, has the level of sophistication applied to compressor bearing technology. Today, the three most common centrifugal compressor bearing technologies are oil-lubricated bearings, refrigerant-lubricated ball bearings, and lubrication-free magnetic bearings.

Johnson Controls

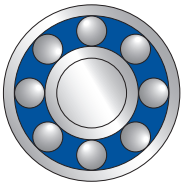
Oil-Lubricated Technologies

A corded phone delivers clear, reliable service from anywhere and to anywhere in the world. It's not new technology, but it still works well.

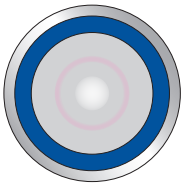
As the traditional choice, oil has done a remarkable job lubricating mechanical systems because it has a high viscosity and remains reliable or constant as a single-phase fluid.

But there are several moving parts and complexities associated with the lubrication system that have to be maintained in order to keep the system working properly.

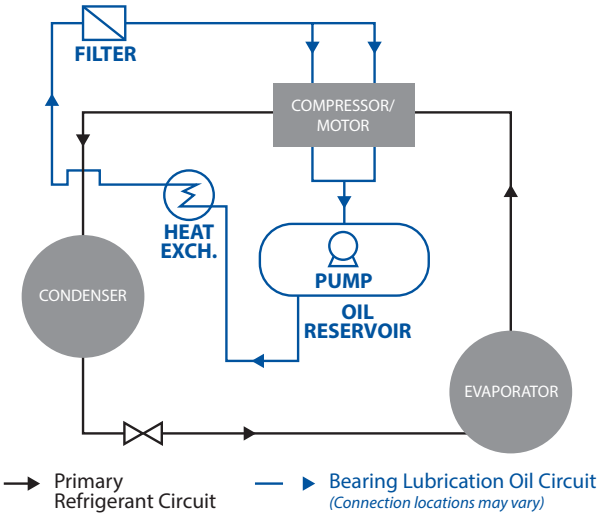
The lubrication sub-system requires a reservoir of oil, a pump to move it throughout the system and a heat exchanger to cool the oil before it is filtered and brought back to the bearings.



Oil-lubricated Ball Bearings



Fluid Film Oil Bearings



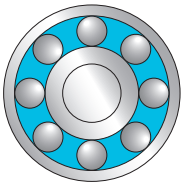
Refrigerant-Lubricated Technology

The cordless phone gives users the freedom to walk around the house, but it comes with limitations. Walk too far and the connection breaks up.

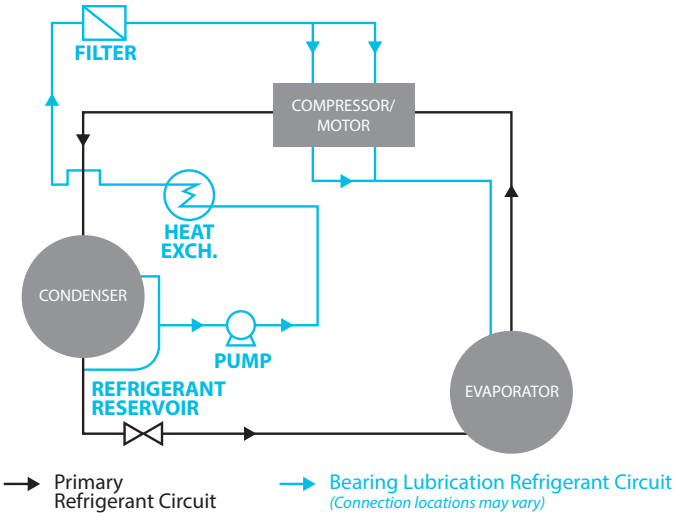
Refrigerant-lubricated technology offers the benefit of removing oil from the system, but refrigerant is not an ideal lubricant because of its low viscosity and tendency to change state as a two-phase fluid.

Like oil, this technology also requires a complex lubrication system with many moving parts.

It requires a reservoir of lubricant (in this case refrigerant), a pump to move it throughout the system and a heat exchanger to cool the refrigerant before it is filtered and brought back to the bearings.



Refrigerant-lubricated Ball Bearings

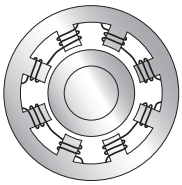


Lubrication-Free Technology

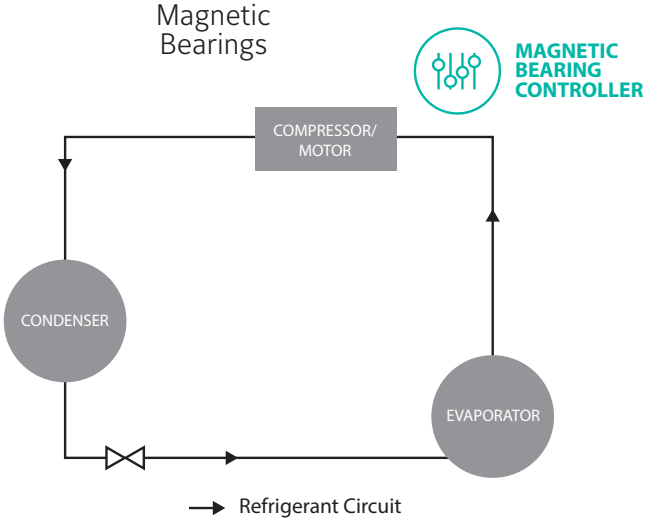
The smartphone changed the industry; it can go anywhere, can do far more than just make phone calls, and is controlled by an elegant, sophisticated system completely invisible to the user.

Magnetic bearing technology represents the next next-generation chiller because it differs significantly from both lubricant-based systems. The magnetic bearing driveline features a single moving assembly suspended on a magnetic field that does not require lubrication.

Due to its non-contact design, the driveline has 80 percent fewer moving parts than traditional oil or refrigerant-lubricated drivelines. It requires no reservoirs, pumps or heat exchangers.



Magnetic Bearings



Less is More: The Business Case for Magnetic Bearings

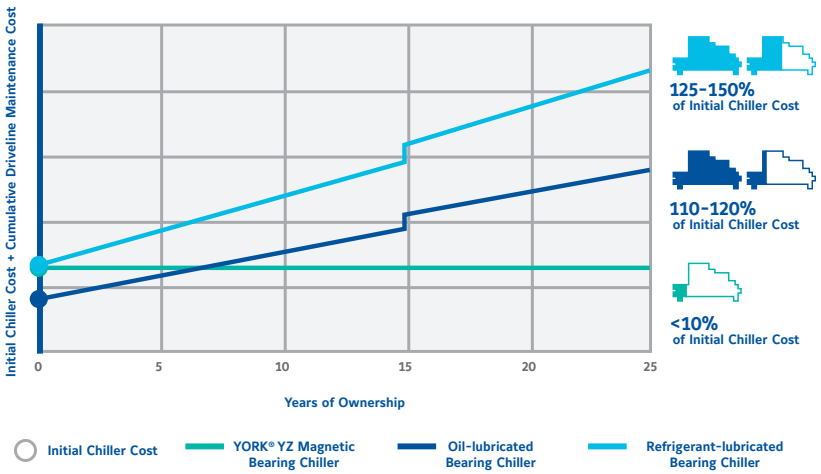
Among these three centrifugal compressor bearing technologies, models that use refrigerant-lubricated ball bearings and lubrication-free magnetic bearings are likely to have a higher initial cost when compared to a traditional oil-lubricated model. But a recent study shows the *total cost of ownership* is by far the lowest with lubrication-free magnetic bearings. The most significant factor: driveline maintenance.

All centrifugal chillers require scheduled maintenance, such as cleaning tubes and checking refrigerant levels. The difference lies within the driveline. An oil- or refrigerant-lubricated driveline can require scheduled compressor teardowns, filter changes and maintenance to the lubrication system over the lifetime of the chiller. By contrast, a magnetic bearing driveline requires no lubrication because its single moving assembly spins without contact or friction, and all of the complexity is contained within the magnetic bearing controller. There are no lubricant sub-system pumps, valves or filters that wear and require maintenance.

The graph on the right illustrates an analysis of driveline maintenance costs conducted by Johnson Controls and based on typical maintenance tasks, frequency and labor rates around the world.

When considered over the 25-year lifespan of a centrifugal chiller, the maintenance savings from a magnetic bearing chiller more than makes up for a slightly higher initial cost.

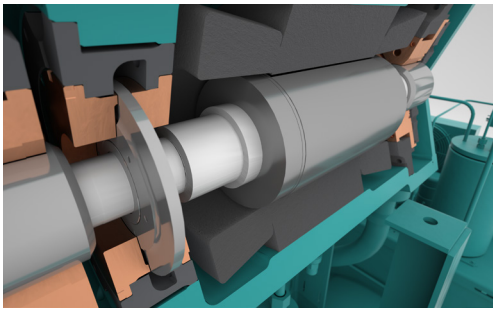
Driveline Maintenance Comparison



Beyond Maintenance: The Added Value of Magnetic Bearing Technology

In addition to offering dramatically lower maintenance costs, there are three other ways in which a magnetic bearing chiller can provide significant benefits to customers.

- Greater precision and control. A magnetic bearing system uses multiple sensors to know and adjust the position of the rotating assembly to within one hundredth the width of a human hair, a process that is repeated 20,000 times per second. Even in a surge or stall, magnetic bearings are able to maintain position within the width of two human hairs; a range imperceptible to the human eye.
- A wider operating map. The speed with which a compressor can run is often limited by the lubrication system. In a magnetic bearing system, where there is no lubrication, there is virtually no limit. A magnetic bearing chiller can operate at any speed necessary to meet a wide range of chiller operating conditions, which can increase both reliability and efficiency.
- Increased uptime. Thanks to minimized driveline maintenance, advanced control, and a wide operating map, customers can expect a magnetic bearing chiller to be up and running more often. This level of reliability can be especially valuable in environments where minimizing downtime is a critical priority, such as a hospital or data center.



The Difference is Clear

With its simplicity, reliability and dramatically lower maintenance costs, today's magnetic bearing drivelines create an entirely new value proposition in centrifugal chillers. And while the benefits of this technology are clear, the industry jargon that's used to describe it can be vague and confusing. Too often, our customers tell us they want an "oil-free" chiller when, in fact, they want one that is "lubricant-free." As this paper shows, there is a significant difference between them.

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