

Hermetic Feedthroughs For Magnetic Bearing Chiller Compressors

One small electrical component makes a big difference in modern chiller compressor

Magnetic bearing chiller compressors have taken the commercial and military HVAC market by storm. And it's no wonder. These highly-efficient compressors can save significant amounts of energy.

In a study conducted by the U.S. Department of the Navy, centrifugal, two-stage magnetic bearing chiller compressors reduced power consumption by 49% compared to traditional reciprocating or screw designs making them the most efficient compressor designs on the market.

The study attributes some of the energy savings to variable speed drives, which make the compressors more efficient at partial loads. But active magnetic bearings played a crucial role in the efficiency gains as well.

This type of bearing relies on electromagnets to levitate a rotating shaft in space (see Figure 1). Position sensors and controls keep the load balanced and centered within the bearing by continually varying the current to the electromagnets as the shaft rotates. With the shaft "floating" within an air gap, magnetic bearings are non-contact, and they don't require oil or other lubricants.

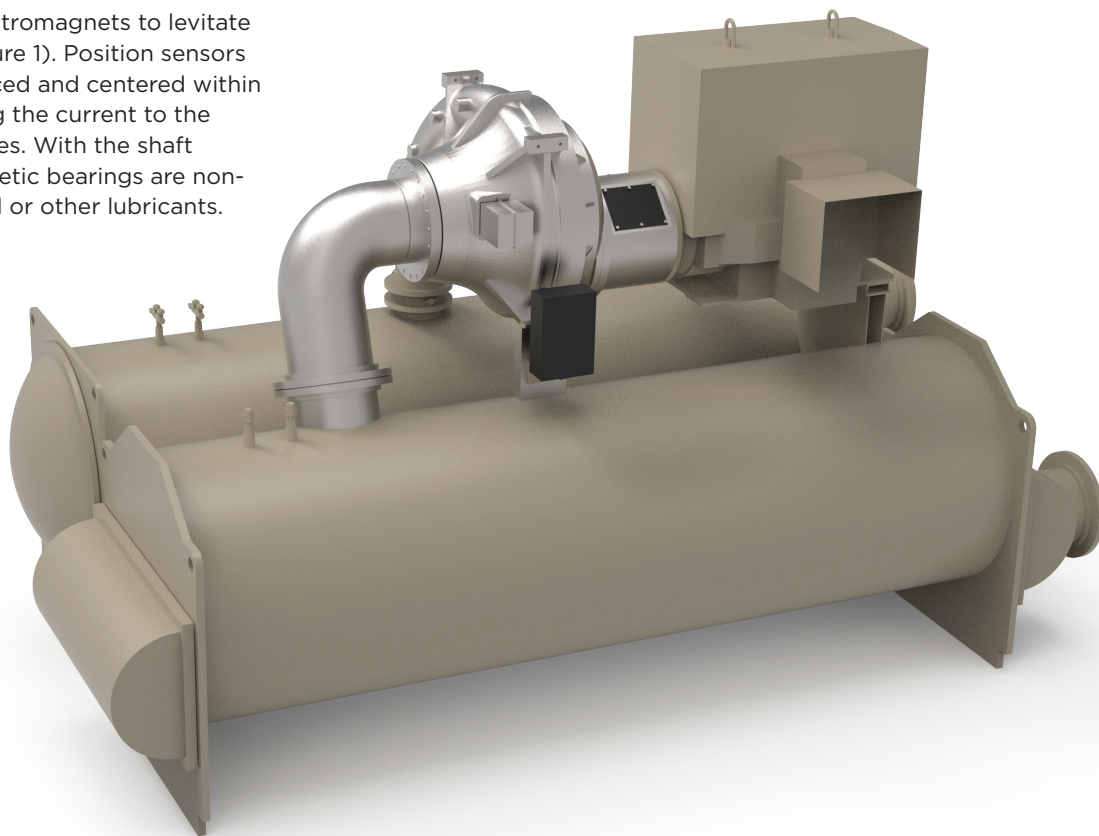
The magnetic bearings contributed to compressor efficiency by eliminating the energy losses associated with bearing friction.

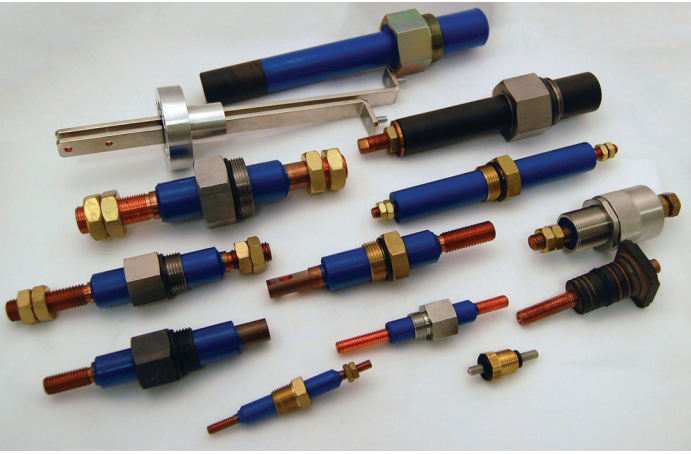
Magnetic bearings have other advantages too. They reduce the wear of internal components, increasing the longevity and reliability for longer service intervals. They also run cooler than traditional bearings.

For all the good they do, magnetic bearings raise the bar on the compressor's electrical requirements. Like traditional compressors, they require provisions for power penetrations through a pressurized compressor housing. Magnetic bearings, however, require additional signal connections that traditional compressors lack. That's where epoxy-based hermetic feedthroughs enter the picture.

FEEDTHROUGHS REQUIRED

A typical magnetic bearing for a chiller compressor can have up to 40 sensors to feed position, speed, voltage, current and temperature data back to the digital controller ensuring that the high speed bearing is operating within specified





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parameters and provides a constant monitor for the heat of the machine which helps to prevent unexpected maintenance downtime. The bearing will also need a 50 to 750 Amp power connection for the electromagnets. A traditional compressor, by contrast, might have only one or two sensors.

Epoxy-based hermetic feedthroughs are essential in this application because the bearings have to function inside a pressurized compressor housing. Compressors running 134A refrigerant are pressurized to 350 psi. Epoxy feedthroughs maintain hermetic performance at much higher pressures—with leak rates of just 1×10^{-9} cc-He/sec at pressures up to 15,000 psi in our case.

To pass power and signal through the compressor wall, most designs rely on two types of feedthroughs, which are kept separate to minimize the effects of EMI. For power, we've developed simple threaded StudSeal variants specifically for compressor applications. These StudSeals carry a UL 984 listing and have successfully served in the air conditioning

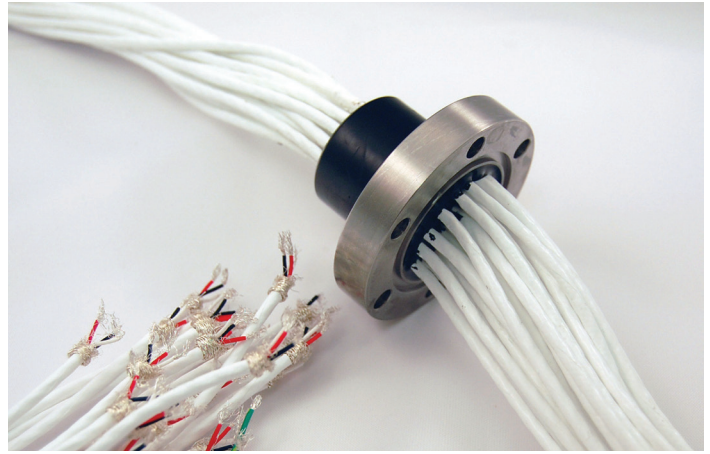
MORE MAGNETIC BEARING USES

Thanks to their oil-free, non-contact design, magnetic bearings are used widely in applications that are sensitive to contamination from lubricants or that require very high-speed shaft rotations, including:

- Flywheel energy storage systems
- Centrifugal pumps
- Turbines
- Motors
- Generators

In addition to running in pressurized environments—as in the case of compressor chillers—magnetic bearings are a natural fit for many vacuum environments, such as kinetic energy batteries.

Whenever the magnetic bearing needs to run under pressure or in a vacuum, it needs a robust feedthrough to handle all the power and signal connections.



DuctorSeal®

and refrigeration market for nearly 40 years. Also, we have passed compatibility testing with newer R134a, R410A, R514A, R513A, R1234ZE refrigerants—in addition to legacy R12, R123 and R22 refrigerants.

For signal, we typically deliver a custom DuctorSeal feedthrough that accommodates all the signal conductors required by the magnetic bearing. To maximize the quality of the magnetic bearing's control signals, we often recommend a "direct sealing" approach—in which we run sensor wires straight through the epoxy feedthrough to the controller PCB. This approach eliminates the voltage drop and signal degradation associated with connectors at the pressure bulkhead wall. And directly sealing to shielded and twisted wires provides an extra measure of EMI protection. Most compressor designs, however, call for a connectorized wire harness, which we can also supply.

EPOXY-BASED SOLUTION

Magnetic bearing compressors in the past relied on glass-to-metal feedthroughs, but epoxy-based feedthroughs have some clear advantages in this application.

- Epoxy offers far more design freedom. We routinely supply custom feedthroughs that freely mix 30 or 40 conductors of all different types.
- Epoxy offers the ability to directly seal shielded and twisted wires, dramatically improving signal quality.
- Epoxy allows the use of fully connectorized harnesses, which eliminated connection points that create additional failure points and cost and reduces BOM/vendor count.
- Epoxy saves space. It's not unusual for an epoxy feedthrough to take up 40% less space than a glass-to-metal feedthrough with soldered pins.

For more information contact the engineering team at Douglas Electrical or visit www.douglaselectrical.com.