WORLD FIRST OIL-FREE COMPRESSOR

Miniaturised centrifugal inverter driven oil-free compressors are at the heart of a new range of leading edge chillers.

In 2006 our industry will be faced with tougher energy efficiency standards. A combination of EU directive 2002/91/EC and Part L of the UK Building Regulations (in itself a response to the Government Energy White Paper – Our Energy Future Creating a Low Carbon Economy) has ensured that this time around higher efficiency standards are here to stay.

So with today's requirement for ever higher efficiency objectives, the introduction of the Climaveneta (a division of DeLonghi) TECS chiller will assist you in meeting these stricter efficiency demands. The Climaveneta TECS chiller range is available in air-cooled versions from 210kW to 1080kW and water-cooled versions from 220kW to 2400kW all with multiple (two, three or four) refrigeration circuits.

New Horizons for Efficiency

For most chiller applications the COP value is taken for the *design* day selection criteria but this only occurs for a few days a year; for the rest of the time chillers operate at part-load condition. For this reason, 'seasonal efficiency' or IPLV (integrated part load value) index is the truly determinant consumption factor. For example, a traditional screw compressor chiller at design will have a COP approaching 2.9 whereas a TECS chiller will have a design COP of 3.3 – an improvement of 13%; however, the IPLV index shows an improvement approaching 40% for the TECS chiller over traditional screw compressor chillers, thereby affording considerable energy running cost savings.

TECS 550 kW Air Cooled Chiller

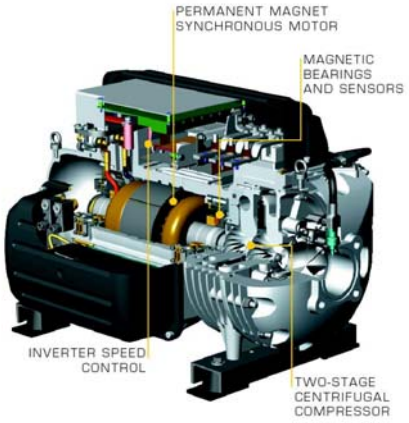
Sustainability

Highest efficiency leads to lowest CO_2 emissions but this is not in itself enough - the performance must be sustained over the entire life of the product. These requirements take us to the compressor at the heart of the TECS chiller – in it's target capacity range there is no other compressor that produces better efficiency in overall operation and the Turbocor compressor uses oil-free technology. This is the key to sustainability because it eliminates the ability of oil to degrade the system's efficiency.

Clearly the selection of compressor type poses one of the most important aspects of chiller selection; the compressor is generally the single largest energy consumer within the HVACR system and is the heart of the chiller. Owners and system designers when surveyed indicate their most important considerations to be: -

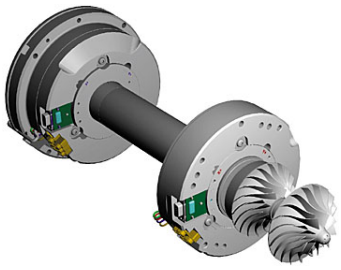
1. Reliability – key is simplicity of design.
2. Low Maintenance – needs to be minimised whenever and wherever possible.
3. Energy Efficiency – ensure COP is high at both full and part load conditions.
4. Sound – so quiet you cannot hear it.
5. Capacity Control – ideally infinite, with wide range and, more importantly, stable operation.

The Turbocor oil-free compressor is combined with industrially proven magnetic bearings, variable speed inverter drive, centrifugal compressor and digital electronic technology.



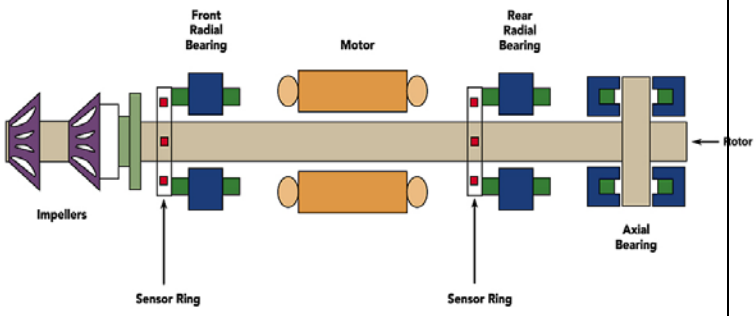
Reliability

A digitally controlled magnetic-bearing system, consisting of both permanent magnets and electro-magnets, replaces conventional lubricated bearings. The frictionless compressor shaft is the compressor's only moving component. It rotates on a levitated magnetic cushion (figure 1). Magnetic bearings – two radial and one axial – hold the shaft in position (figure 2).



(fig. 1)

When the magnetic bearings are energised, the motor and impellers, which are keyed directly to the magnetic shaft, levitate. Permanent-magnetic bearings do the primary work, while digitally controlled electromagnets provide the fine positioning. Four positioning signals per bearing hold the levitated assembly to a tolerance of less than 7 micron. As the levitated assembly moves from the centre point, the electromagnets' intensity is adjusted to correct the position. These adjustments occur 6 million times a minute. The software has been designed to automatically compensate for any out-of-balance condition in the levitated assembly.



(fig. 2)

Low Maintenance

Oil management, particularly as it pertains to the lubrication of compressor bearings, is a critical issue in refrigeration system design. But with magnetic bearings, this issue is avoided. Avoiding oil management systems means avoiding the capital cost of oil pumps, sumps, heaters, coolers, and oil separators, as well as the labour and time required to perform oil-related services. Reports indicate that for many installations, compressor maintenance costs have been cut by more than 50 percent.

In fact, the only required regular maintenance of the compressor is the quarterly tightening of the terminal screws, the annual blowing off of dust and cleaning of the printed circuit boards, and the changing of the capacitors every five years.

Efficiency

Among the key parameters affecting performance are capacity and efficiency (IPLV). The compressor's capacity ranges from 200 kW to 320 kW depending on the operating conditions.

Efficiency improvements stem from a combination of the centrifugal compressor, permanent-magnet motor and magnetic bearings. Within the compressor, efficiency is affected by the compressor isentropic efficiency (the efficiency of the impellers) the motor and the bearings. Typically, traditional induction motors of this size are in the 92-percent efficiency range. This compressor's permanent magnet motor has an efficiency of 96 to 97 percent.

Efficiency is further enhanced with the use of magnetic bearings, that avoid the friction associated with traditional oiled bearings. Conventional bearings can use as much as 10,000 W, while magnetic bearings require only 180 W. That amounts to 50 times less friction loss.

Motor and Inverter

Most hermetic compressors use induction motors cooled by either liquid or suction-gas refrigerant. Induction motors have copper windings, that when alternating current is run through them, create magnetic fields that cause the motor to turn. These copper windings are bulky, adding size and weight to the compressor.

Two-pole 50-Hz induction motors operate at approximately 3000 rpm. A higher number of revolutions per minute can be obtained by increasing the frequency. Compressors that require higher shaft speeds tend to use gears. While gears are proven technology, they create noise and vibration, consume power and require lubrication.

The magnetic-bearing compressor features a synchronous permanent-magnet brush-less DC motor with a completely integrated variable-frequency drive (VFD).
The stator windings found on conventional induction motors are replaced with a permanent-magnet rotor. Alternating current from the inverter energizes the armature windings. The stator (excitation) and rotor (armature) change places. No commutator brushes are required. The motor and key electronic components are internally refrigerant-cooled, so no special cooling is required for the VFD or the motor.

The use of permanent magnets instead of rotor windings makes the motor smaller and lighter than induction motors. Using magnetic-bearing technology, a 250kW capacity compressor weighs about one-fifth the weight of a conventional screw compressor.

Control

A variable-speed drive (VSD) is required for the motor to operate. The VSD varies the frequency between 300 and 800 Hz, which provides a compressor-speed range from 18,000 to 48,000 rpm. This avoids a gear set. The VSD is integrated into the compressor housing, avoiding long leads and allowing key electronic components to be refrigerant-cooled. The VSD also acts as a soft starter; as a result, the compressor has an extremely low start-up in-rush current: less than 2 amps, compared with 200 amps for a traditional screw compressor with a star-delta starter.

With the integration of the motor, VSD, and magnetic-bearing system, the capacitors required for the motor and drive can be used as a backup power source for the bearings in the event of a power outage or emergency shutdown.

The new TECS chiller range features user interface and adjustment software with a graphic display for reading and writing control parameters. The controller also comprises a mimic panel for real-time visualisation of compressor operating status. Chillers can communicate with Modbus, LonWorks or BACnet as well as other systems.

Sound

Because the rotating assembly levitates, there essentially is no structure-borne vibration. The magnetic bearings create an air buffer that prevents the only major moving part – the motor rotor – from transmitting vibration to the structure.

Similarly, sound levels are extremely low, primarily because of refrigerant-gas movement through the compressor and the rest of the refrigeration system. There are no tonal issues, such as those found with some screw compressors and the noise occurs in the higher octave bands where it is easier to attenuate. When two magnetic-bearing compressors are integrated into a TECS 550 kW air cooled water chiller, the sound pressure is 64 dB(A) at 1.0 m under standard Eurovent conditions. Visit www.powermaster-ltd.co.uk (products) to hear the actual sound difference for yourself.