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Energy Efficiency & Customer Research & Development
Technology Brief…The Turbocor™ Compressor

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Background

During the summer of 2004, the California Railroad Museum invested in a cutting-edge technology known as Turbocor™. The Turbocor is a centrifugal refrigeration compressor that uses oil-free, magnetic bearings. According to Danfoss Turbocor Compressors Inc., the manufacturer, Turbocor compressors are designed for 50 to 300-ton chiller and rooftop air conditioner applications and offer the following benefits:

- Energy efficient: Up to 30% more efficient than conventional compressors in the same capacity range.
- Oil-free operation: No oil-management hardware, oil return issues, thermal degradation and significantly reduced maintenance costs.
- Compact: About one-fifth the weight (less than 300 lbs) and one-half the size of many conventional compressors.
- Extremely quiet: 70 dBA (conversation level) sound with virtually no vibration.

The Turbocor™ compressor
Source: www.turbocor.com

- Soft-start: Low starting power requirements (2 amps).
- On-board digital controls and power electronics: Enables effective monitoring, control, self-correction of operation and diagnostics of the compressor.
- The integral variable frequency drive (VFD) and controls allow for effective staging of multiple compressors and efficient operation under a wide range of load conditions.

HVAC 101: Issues with Oil

Like automobile engines, conventional refrigeration compressors contain many moving parts and must rely upon oil for lubrication. If these components are not properly lubricated, they will quickly overheat due to excess friction. The problem is that this oil often migrates into various parts of the refrigeration system where it doesn't belong and reduces the efficiency of the system. According to studies conducted by the TRANE company, oil entrained in a chiller's refrigerant may significantly degrade the performance of the chiller and increase its operating costs (please refer to Table 1).

Effects of Oil Contamination

Oil in evaporator	Performance loss
1 to 2%	2 to 4%
3 to 4%	5 to 8%
5 to 6%	9 to 11%
7 to 8%	13 to 15%

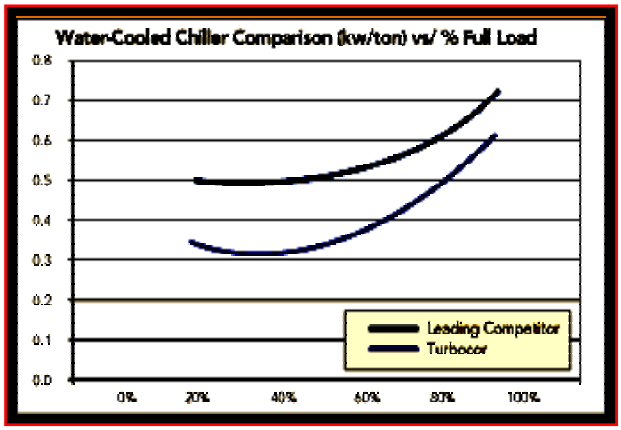
During one study conducted by the American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE), when refrigerant samples taken from ten randomly chosen, older chillers were analyzed, the oil contamination levels ranged from three to twenty percent! To combat the problem of oil migration, the HVAC industry currently uses strategies such as oil-purgers, refrigerant decontamination systems and piping design techniques.

By contrast, Turbocor compressors have only one moving part (the rotor shaft / impeller assembly) and use non-contact, magnetic bearings instead of conventional oil-lubricated bearings. Since the rotor shaft assembly rides 'on a magnetic cushion,' oil is not needed for lubrication. This eliminates the problems associated with oil migration described above and the need to install oil-management hardware.

Rotor shaft /impellor assembly
Source: www.turbocor.com

Energy Savings Potential

During the summer of 2005, two local projects will be closely monitored to accurately determine energy savings. Until then, however, it may be helpful to present graphs and calculations from the manufacturer. The ones shown below are taken from www.turbocor.com and reprinted with permission.



Source: www.turbocor.com

The chart above compares the energy performance of a water-cooled, oil-flooded screw compressor versus a Turbocor 75-ton compressor. According to the manufacturer's chart, the Turbocor is more efficient under all load conditions.

Since most chillers operate mostly under part load conditions, it is very important to consider more than just peak load efficiencies. Fortunately, the American Refrigeration Institute (ARI) has developed a rating standard known as Integrated Part Load Value (IPLV). This standard provides consumers with a comparison for the overall energy efficiency of HVACR products. As the name implies, IPLV integrates energy efficiencies at 100%, 75%, 50% and 25% equipment load points and is weighted for standard operating conditions and time at those conditions. The calculations shown below illustrate the impact of IPLV upon annual energy costs.

Typical water-cooled chiller operating cost savings calculation

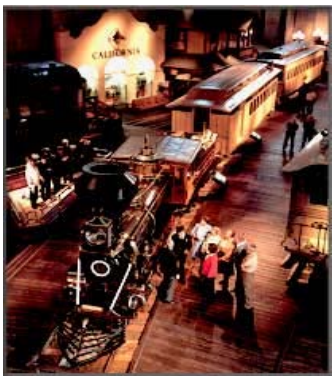
	Turbocor	Screw Compressor	Savings
IPLV kW/TR	0.41	0.63	0.22
Tons capacity	75	75	—
kW	30.75	47.25	16.5
Annual operating days	180	180	—
Operating hours per day	10	10	—
Total annual kWh	55,350	85,050	35,640
Power cost ($/kWh)	$0.10	$0.10	—
Annual operating cost	$5,535.00	$8,505.00	$2,970.00
2-year savings			$5,940.00
3-year savings			$8,910.00

Source: www.turbocor.com

Featured Project:

California State Railroad Museum

The **California State Railroad Museum**, located in Old Sacramento, is a complex of historic buildings and unique attractions for visitors of all ages. The museum features lavishly restored trains, engaging exhibits, and special events throughout the year.



Source: California State Railroad Museum Website: www.csrmf.org

In order to preserve precious artifacts, museums are often required to provide climate-controlled space 24 hours per day, 365 days per year in their exhibit halls. Unfortunately, this requirement often translates to high energy and maintenance costs.

Faced with skyrocketing maintenance costs and budget shortfalls, the museum decided to replace its existing 360-ton, centrifugal chiller with two, 160-ton, McQuay chillers equipped with Turbocor centrifugal compressors. The new chillers will be installed in November of 2004 and are expected to save the museum over $25,000 in annual energy costs alone. Once the project has been completed, the site will serve as a demonstration site for this new technology.

Source: manufacturer's brochure

Stay tuned for a full technology report in the fall of 2005! In the meantime, if you want to learn more, please visit: www.turbocor.com

The Customer Advanced Technologies Program

SMUD's Customer Advanced Technologies (C.A.T.) program works with customers to encourage the use and evaluation of new or underutilized technologies. The program provides funding for customers in exchange for monitoring rights. Completed demonstration projects include lighting technologies, LED lighting systems, residential building shell construction, geothermal heat pumps, indirect / direct evaporative cooling, non-chemical water treatment systems and a wide variety of other technologies. For more program information, please visit: http://www.smud.org/education/cat/index.html