

Application 1: Hershey's Chocolate World Data Center (Hershey, Pennsylvania, USA)

Application

The Hershey Company is a global confectionery leader famous for its chocolates, sweets, and snacks. In 1973, it opened Hershey's Chocolate World in Hershey, Pennsylvania, and then expanded to locations that today range from Times Square to Dubai to Shanghai. To serve chocolate customers and fans worldwide, Hershey's Chocolate World also operates a data center located in Hershey. The data center operates around the clock using a chiller providing cooling for the electronic equipment.

Cooling technology

To handle these conditions, the data center employs one 180-ton (600 kW) Smartdt WA062.2 water-cooled chiller using two Danfoss Turbocor® TT300 oil-free centrifugal compressors. Optimized for R-134a refrigerant, each compressor provides up to a nominal 90 tons of refrigeration utilizing two-stage centrifugal compression.

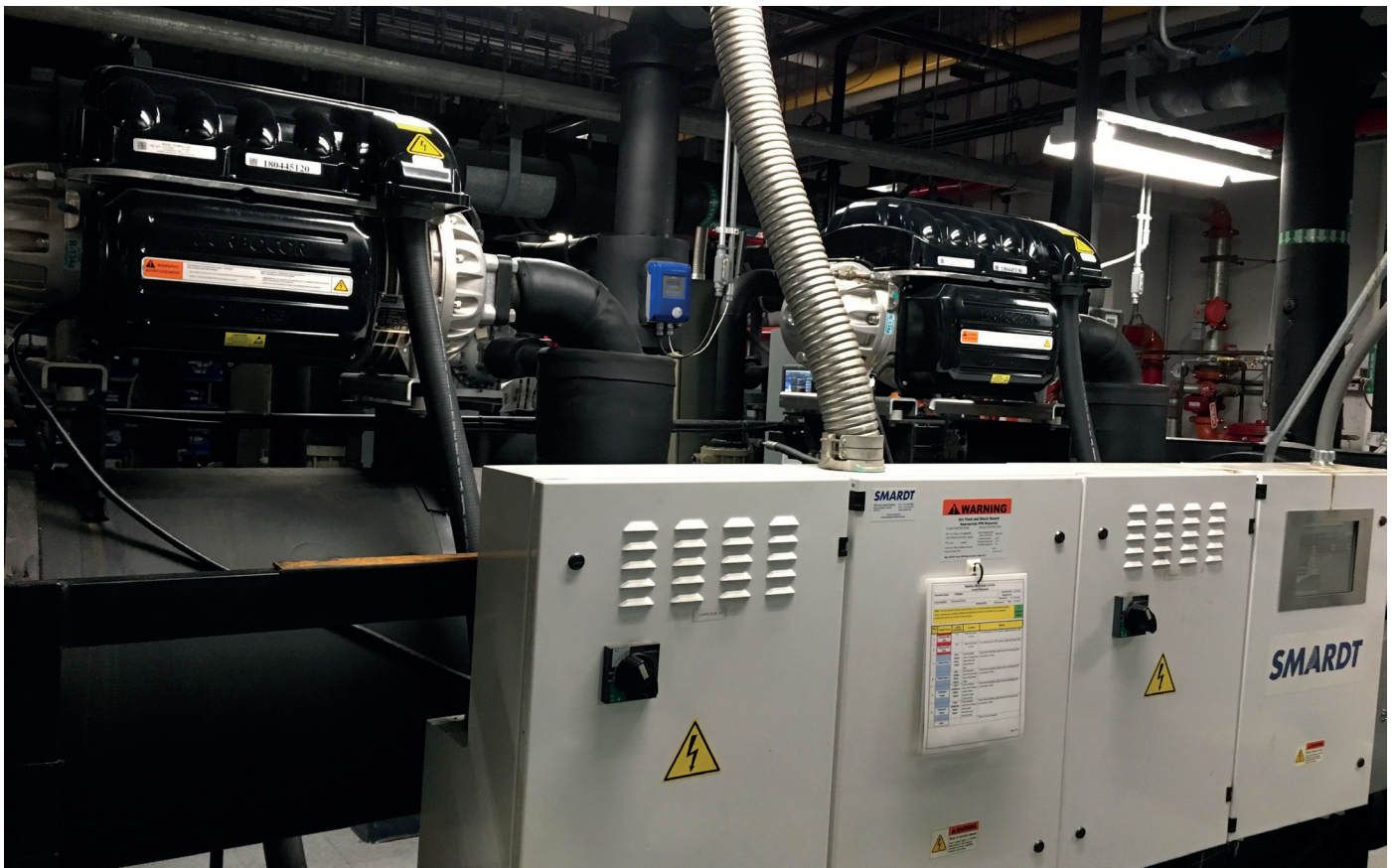
Performance testing

The two compressors submitted for performance testing incurred over 38,967 and 38,928 hours of operation, respectively, resulting from 24/7 operation in data-center cooling for more than 10 years.

In January 2018, the compressors were removed from the chiller and replaced with new TT300 compressors. The existing compressors were sent to Danfoss' test laboratory at Innovation Park in Tallahassee, Florida.

TT300 Compressor One tested at 48.0 kW power consumption and Compressor Two, 49.0 kW power consumption, at pressures, RPMs, and capacities shown in Tables 1 and 2. (Although no official test standard pertains to standalone centrifugal compressors, AHRI 540-2015 was used as a test reference as explained below.) These results fall within the AHRI 540-2015 uncertainty limits for the verification of published ratings for an application envelope with 95 percent for minimum mass flow and minimum refrigerating capacity and with 105 percent maximum power input.

These results were then compared with the original test parameters for each compressor when they were tested and shipped in 2007 from the Danfoss factory to the chiller manufacturer.



Test results and conclusions

- Tested deviation over a decade: From its original 2007 power test value of 46.8 kW, Compressor One deviated 2.56 percent higher 11 years later (Table 1). Mass flow was 2.13 percent higher. From its original 48.7 kW value, Compressor Two deviated 0.62 percent higher for power consumption (Table 2) and was 0.15 percent higher in mass flow.
- Performance consistency: The range of deviation for kW and mass flow (Tables 1 and 2) were all within the acceptable uncertainty limits for performance per AHRI 540-2015. This range approximates the expected performance values for new compressors. The results show the Danfoss Turbocor® TT300 oil-free compressor experienced no significant performance degradation over an 11-year period. This evidence indicates the compressors provided consistent, long-lasting performance that is likely to extend over the life of the chiller.

- Customer satisfaction: Steven C. Miller, senior maintenance specialist for The Hershey Company Data Center, notes that “in a data center, reliability is everything. This chiller with Danfoss Turbocor® TT300 magnetic-bearing compressors has been, and still is, an extremely reliable chiller. Operational and maintenance costs are way down, because there have been very few repairs over the 10+ years this chiller has been in service. We originally selected this technology due to low noise levels and a track record of success at other sites. In our case, the chiller with Danfoss Turbocor® compressors has met and exceeded my expectations regarding performance.”

Table 1: Compressor 1 performance values for Hershey's Chocolate World data center					
<i>TT300 Compressor (90 tons nominal)</i>	Suction Pressure	Discharge Pressure	RPM	Power (kW)	Mass Flow Rate (kg/min)
2007 test	359.33	918.88	31905	46.8	101.08
2018 test	362.1	919.75	30656	48.0	103.23
Deviation	0.77%	0.09%	-3.91%	2.56%	2.13%

Table 2: Compressor 2 performance values for Hershey's Chocolate World data center					
<i>TT300 Compressor (90 tons nominal)</i>	Suction Pressure	Discharge Pressure	RPM	Power (kW)	Mass Flow Rate (kg/min)
2007 test	353.0	912.39	32002	46.7	100.18
2018 test	354.74	914.91	32005	49.0	100.33
Deviation	0.49%	0.28%	0.01%	0.62%	0.15%

1 “Heating and Cooling.” Energy Star. Accessed October 30, 2018. https://www.energystar.gov/sites/default/files/buildings/tools/EPA_BUM_CH9_HVAC.pdf, page 3.

2 “ASHRAE Research Project Report RP-751: Experimental Determination of the Effect of Oil on Heat Transfer in Flooded Evaporators with R-123, R-134A.” ASHRAE. 1999.

3 Ray Good. “Emerging Oil Free Technologies.” Accessed October 30, 2018. https://utahashrae.org/images/downloads/Chapter_Meeting/slc_ashrae_emerging_oil_free_technologies_final.pdf, slide 14.

4 “Improving the Energy Efficiency of Air Conditioning and Refrigeration Systems.” Power Knot. Accessed October 30, 2018. <http://www.powerknot.com/2017/03/02/improving-the-energy-efficiency-of-air-conditioning-and-refrigeration-systems>.

5 Ying Zheng and Michael Bellstedt (Minus40 Pty Ltd). “Final Report: Compressor Degradation Assessment and Wear Mitigation Strategy.” Meat & Livestock Australia Limited, North Sydney NSW, Australia. December 2014, page 19.