

RSES Journal

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Contractors Find Valve Beats the Defrost Blues

A newer valve has proven to reduce defrost cycles and maintain even evaporator temperatures, outcomes that are causing a growing number of refrigeration contractors, end users and manufacturers to utilize the technology

BY D.A. JENNINGS

Every segment of our industry has its challenges. Supermarket operators and service engineers have considerations that differ from other industries. It is in the supermarket that many technicians see their first parallel compressor "racked" system, hot-gas defrost methods, multiple uneven refrigeration circuits, and complex pressure and oil control systems.

While industrial plants often have redundancy, and many commercial refrigerated storage rooms can remain closed during periods of refrigeration interruption, supermarket display cases bring high levels of urgency due to direct customer visibility and product contact. The supermarket offers several unique challenges for the store operators and service contractors alike.

For example, infiltration is of concern for any refrigeration application. Few applications face the immediate effects of infiltration as in a display case. Air circulation provides the barrier against external forces and load. The impinging higher ambient air and humidity gradually overcome the curtain, develop frost, build ice and reduce the cfm of the circulating air. This allows the ambient air to overpower the diminished air curtain cfm and humidity is drawn more rapidly into the display case.

While infiltration cannot be eliminated, a more uniform evaporator temperature with a level of sublimation can maintain additional humidity balance within an open refrigerated display case. Higher and more uniform evaporator temperature will reduce the rate of frost formation and limit humidity infiltration.

In cycling refrigeration systems equipped with specialized valve technology such as the one made by XDX Innovative Refrigeration, Arlington Heights, Ill., the evaporator coil temperature can approach the supply air temperature and operate within the dew point of that air for duration sufficient to cause some degree of sublimation.

Sublimation describes the change of matter from one state to another, and in this reference, it refers to moisture that returns from the evaporator surface to the circulated air. It reduces latent load and allows for improved frost formation.

For example, the graph on the next page shows a reach-in freezer evaporator that reached a temperature of -26°F (.00019 lbw/lbda or pounds of water per pound of dry air). The relative humidity of the supply air is near 50 percent at -14.5°F with a dew point of near -26°E .

The warming of the evaporator surface, and especially the fins, is important. Frost is able to move back into the air in the area of the coil between the fins, reducing the bridging that normally impedes airflow. The result is extended periods between defrost cycles. (A photo of a reach-in freezer evaporator coil after 16 hours of operation in the conditions demonstrated in the accompanying graph is on the next page.)

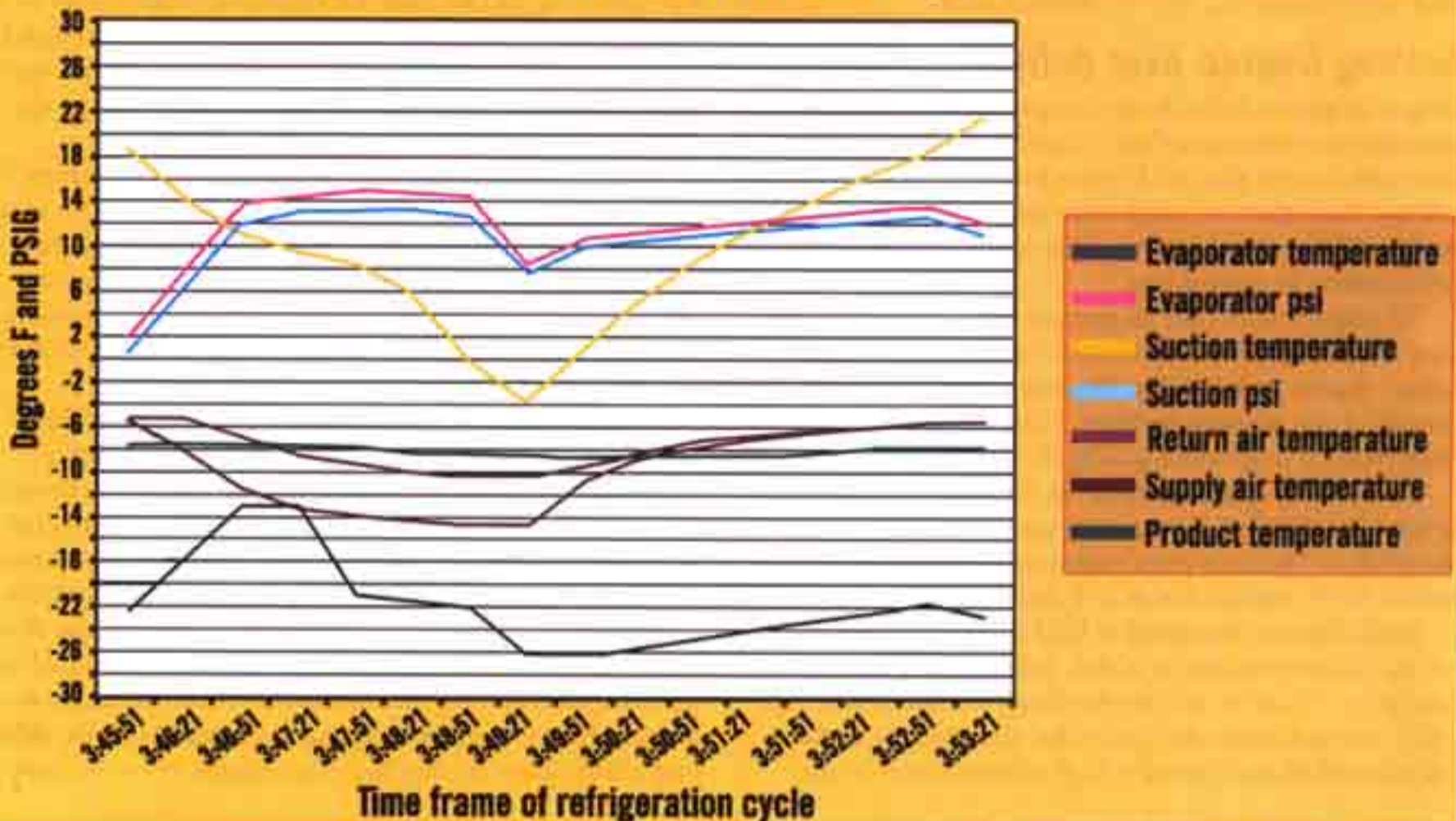
The graph also demonstrates the temperature of the initial pass of the evaporator coil (blue line) of a reach-in freezer warming toward the supply air temperature (brown line) for at least a full minute during the run cycle. The evaporator temperature remains within the dew point of the supply air temperature for approximately 80 percent of the refrigeration portion of the cycle, even at cabinet temperatures of -10°F .

Solving a problem

A Wisconsin contracting firm, Dostal Geothermal Systems Inc., installed XDX's X-Stream valve into a highly demanding freezer applications. The store operator is now using an open coffin case to pull down freshly packaged meats, which was not possible prior to the installation.

"I'm impressed. Before we converted the case it was a

Graph of data collected from a -14.5° F reach-in freezer evaporator



The graph demonstrates data points along the evaporator coil, in the air stream and of the product in a reach-in freezer operating at -14.5° F. The graph shows that the evaporator temperature can operate within the dew point of the supply air temperature.

maintenance pain. Every two to three weeks the case would have to be unloaded, taken apart and rinsed out with warm water to get the ice out," explains Dennis Dostal of Dostal Geothermal Systems Inc.

"We had up to six defrosts a day and at times it would still ice over. Since the installation of the X-Stream valve, we have had only one defrost per day, the evaporator coil never freezes over and the case runs a consistent -12° F," he says.

The valve operates through two-stage expansion and alters the bi-phase flow within the evaporator, which creates a thin film for more even and rapid heat transfer. XDX's Adjustable Refrigerant Metering Evaporator Device allows for complete and detailed flow adjustment at the entry to the evaporator, providing the installing contractor the ability to achieve maximum evaporator performance.

The resulting annular flow system can provide evaporator temperature uniformity, build frost and condensation uniformly, and increase the rate of initial cycle and post-defrost pull-down.

Humidity is rarely as visible as in a supermarket. Water droplets and films of frost can cause customers to question the refrigeration storage conditions. High temperatures during defrost cycles and lengthy pull-down periods greatly contribute to visible frost or condensate.

A defrost air temperature near 30° F can hold nearly



A reach-in freezer evaporator coil is shown after 16 hours of operation at -14.5° F. The absence of frost bridging between fins extends periods between defrost cycles.

7½ times the amount of moisture than at -10° F. During the pull-down period, in return to the temperature set point, the moisture once contained within the warmer air is deposited along the evaporator, on product and on box surfaces. Elimination of even one defrost cycle can affect visible humidity.

Product quality is compromised, whether as in frost on cylinders of ice cream, drying of salads, fresh produce

and cut meat, or moisture inside packages. It also causes freezer-burn, which is more aptly called defrost-burn. Each contributes to a loss of product sales.

Getting frosted over defrost

Defrost is unavoidable. Every contractor has witnessed customer concern regarding a multi-deck meat display case with fogged glass and warm product. Meat managers will say it's in defrost, while meat department personnel time product cutting and stocking around refrigeration performance to reduce loss.

"We experienced over 50 percent fewer defrost cycles after the installation of XDX into the Hussman Impact cases," claims Jack Gridley, director of meat and seafood, Dorothy Lane Markets in Ohio. "And we saw a dramatic improvement in product quality in our meat case."

The affect of a defrost cycle on the exterior of product is directly related to the bacteria growth on the surface of the product. Bacteria grow exponentially as temperatures exceed 36° F, and double at 2° F intervals above 36° F.

Meat cases are designed to hold product temperatures below the temperature at which coliform and aerobic bacteria grow. However, during extreme conditions and especially during routine defrost cycles, the product surfaces are exposed to exceptionally high temperatures as the

evaporators terminate at 45° F to 55° F.

The X-Stream technology was installed at 134 Tyler Refrigeration and Kramer Refrigeration evaporators in a Super Kmart in Fresno, Calif. Super Kmart experienced defrost reductions from four to one per day. The product shelf life of meat and seafood was extended, and product-shrinkage was reduced by more than 40 percent.

Representatives from Carrier Commercial Refrigeration (Tyler and Kramer are divisions of Carrier) met with executives from Kmart and the installing contractor as they reviewed the site. The contractor presented a litany of changes due to installation of the valve, including product-quality improvement, temperature reduction and verifiable energy savings of 14 percent to 32 percent.

"As significant as the reported product quality, the improvement to the compressor temperatures and oil return also were major," explains Mike Micak Sr., project manager, Carrier. "We met with the installing contractor who reported that his team removed refrigeration oil totaling more than seven gallons from the retrofitted systems."

Mechanical benefits are attributed to the annular flow system from the valve technology. "Suction filters had to be changed following the installation of the valves, as the annular flow within the evaporator brought back the debris and refrigeration oil that had been logged since the store



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was installed several years earlier," Micak says.

Counter-flow hot-gas defrost methods over time can reduce evaporator performance. "After years of operating reverse-flow defrost, with condensed liquid refrigerant slowly exiting the evaporator through a check valve, the oil and debris slowly reduces defrost cycle effectiveness as well as heat transfer during the refrigeration cycle, extending defrost durations," explains Roger Wightman, director of engineering, XDX Innovative Refrigeration.

"It is not uncommon to visit the back room of a supermarket and find that the refrigeration technicians needed to increase defrost durations from where they were originally set due to this gradual performance loss. Our annular flow system allows the contractor to return display cases to their original manufacturer specified set points, although often that is just the beginning," Wightman says.

Performance, reliability are key

Refrigeration equipment and display case manufacturers have the additional challenges associated with limited access to evaporators for maintenance. Product and customer traffic impedes work and makes refrigeration service more costly.

The limited service access makes system performance and reliability even more important. Soft costs often go

unnoticed, but affect the bottom line. Colder temperatures and reduced frost reduce service issues and boost product quality.

"I have installed an XDX X-Stream valve on my Hussman RL-5U ice cream freezer," says Tom Wisted, president, Wisted's Market in northern Illinois. "Prior to installation, this freezer held -15° F with three defrosts per day.

"After retrofitting my case, I now consistently hold -20° F and require only one defrost per day not lasting more than 20 minutes. I have also noticed the lack of frost buildup on my ice cream, something that used to occur quite regularly prior to XDX," he adds.

This technology also has been beneficial for other industries as well, such as blood plasma storage.

"At higher compression ratios, such as in blood plasma storage with evaporator temperatures below -40° F, we have seen that XDX can bring adverse oil and compressor temperature conditions into satisfactory ranges," notes Carrier's Micak. "We are focused on bringing this type of value-added engineering to our customers. We are simply raising the industry's performance bar." ♦

D. A. Jennings is a freelance technical writer for the Jennings-Sauter Group. For more information on XDX and online computer-based training, visit <http://xdxusa.com>.

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