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MAKING IAQ A CLASS ACT

The cover story serves up a lesson that will move you to the head of the class on how to maintain and improve indoor air quality in schools.
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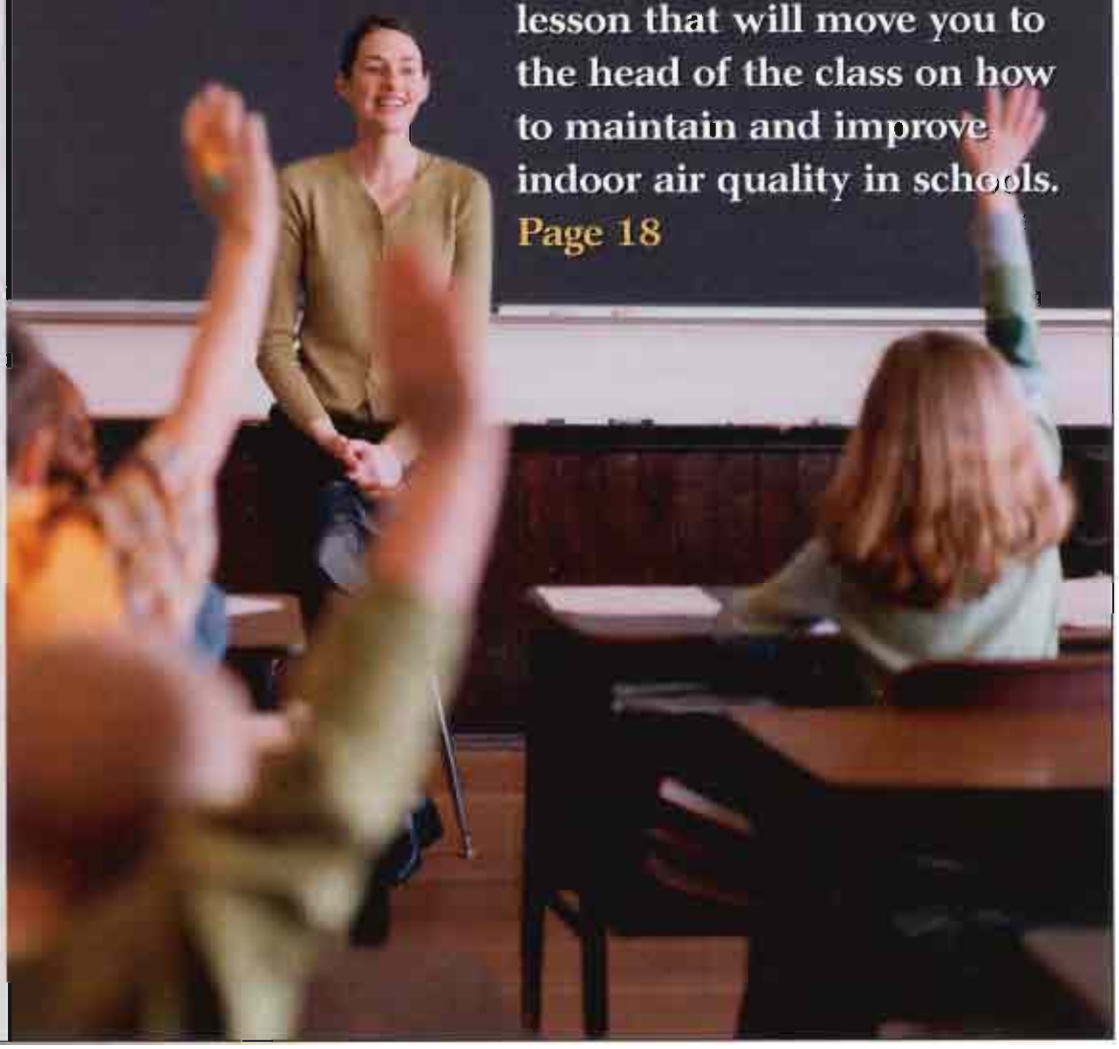

NEW TECHNOLOGY

New Valve Boosts System Performance

A new refrigeration valve system has a proven track record for maintaining proper temperatures in cold and medium-temperature applications and also reducing and sometimes eliminating defrost cycles

BY DAVID A. WIGHTMAN

U.S. supermarkets consume nearly 55 billion kwh of electrical energy annually. Refrigeration and air-conditioning systems account for as much as 75 percent of this energy use. A significant portion of this energy is used to satisfy the cooling load of refrigerated display cases.

Previous testing demonstrates that much of this energy is engaged in latent heat removal and frost removal in the refrigerated display cases. Refrigeration systems are also the largest energy consumers in refrigerated warehouses, with similar energy consumption parameters engaged in moisture removal.

Direct expansion (DX) is the primary refrigerant-feed method and has been since the introduction of the thermostatic expansion valve (TXV) in the 1940s. Significant development has improved refrigerant-to-air heat exchanger design in the past decade. Refrigerant metering devices now include electronic expansion valves to improve coil performance through better control and by reducing superheat requirements at the exit of evaporator coils.

Field case studies of refrigeration systems operating with a new valve that alters the vapor fraction and flow regime of refrigerant entering the evaporator demonstrate improved overall system performance (see sidebar on page 16). The results show that better quality refrigerant in the initial few passes of the evaporative coil can increase stability throughout the coil and even allow for a greatly reduced evaporator superbeat. In addition, energy savings of 18 to 24 percent are possible, which has been verified in tests by Underwriters Laboratories.

Results are showing improved performance on the order of at least 15 percent reduction in compressor run time, with markedly better results as applications are pushed to extremes

Case studies also have shown that the new product improves heat transfer coefficients and redistribution of frost on medium- and low-temperature air-cooling coils. This permits longer periods between defrost cycles, even to the point of elimination of defrost requirements. Frost forms more uniformly across the entire evaporator instead of "bridging" between fins in one area.

The new valve is placed in the liquid line of the system in series with the conventional expansion valve, where it serves to enhance the two-phase flow characteristics of the saturated refrigerant. A system using this valve provides turbulent bi-phase refrigerant flow at the evaporator coil.

Since the heat transfer has improved, the cooling portion of a refrigeration cycle is reduced and results in more rapid achievement of the temperature set-point. Because the coil has more uniform temperature with the new valve in place, frost buildup is reduced compared to conventional coils, which may have excessively cold-flooded portions.

Some dense frost accumulates over the entire coil surface with the appearance of a thin glaze. During normal cycling operation of the system, some of the frost subli-

Test Projects Show New Valve Is Getting Positive Results

BY WALLACE "DOC" EMMERT

Does the new valve system live up to its hype? According to contracting companies that agreed to install the product in refrigerated equipment on the West Coast and in the Midwest, the answer, so far, is yes.

Bill Victorino, sales manager, Polar Refrigeration, Salinas, Calif., for one, is sold on the new technology. A case in point is the owner of Super Maxx, a grocery store in Castroville, Calif., who formerly was dissatisfied with frost buildup on frozen product.

"We'd never used XDX valves before that job so we didn't know if they worked or not," Victorino says. The company installed two new valves in the frozen food and ice cream cases.

Before the valves were installed, the frozen food cases were operating at 0° F with two 35-minute electric defrosts, which improved to -4° F with one defrost after converting to the new valve. The ice cream case formerly operated at -10° F with two 60-minute electric defrosts daily and now operates at -15° F with one defrost.

Polar Refrigeration also is the service contractor for Monterey Pasta Co., a food processor of pasta and sauce products. Monterey Pasta was approached by Polar about participating in an energy-saving project sponsored by utility company Pacific Gas and Electric using the new valve.

Polar suggested installing the new product in three locations where refrigeration capacity was strained due to increased production and where the plant also wanted to reduce peak electricity usage. The first location was a spiral blast freezer that was designed to cool freshly cooked pasta to a temperature range between 4° F and 13° F.

When production nearly doubled, the freezer's capacity reached its limit, resulting in a daily mid-day shutdown to defrost the iced coils. In fact, it was necessary to use electric heat, air circulation and applied water to clear the coils before resuming production.

After the new valves were installed and adjusted to achieve maximum evaporator efficiency, the results surprised everyone. During one 15-day period, there was only one defrost.

According to Gary Bever, technician, Polar Refrigeration, "We're holding at 3° F and the compressor actually cycled off. That's never happened before."

"That freezer has held temperature longer and they've increased production by not having to shut down," Victorino says.

The second site considered for the project at Monterey Pasta was a freezer where 185° F sauce was cooled and stored after shipment from the cooking facility to the packaging areas. Demand for its sauce caused Monterey Pasta to double production. Although refrigerated storage increased, the product freezing time was strained.

After the new valves were installed and adjusted, the refrigeration capacity actually increased. Since the improvements, temperature monitors indicate that when a new, hot batch of sauce is brought into the room (adding "load spikes") the room returns to temperature set points much faster.

At a third site of Monterey Pasta, Polar Refrigeration monitors the plant's product storage and shipping facility. According to Victorino, "Following the installation of the new valves on four of 10 evaporator coils, the difference between those four and the previous conventional DX coils can be clearly seen. Data showed that while maintaining set-point temperature, the four new coils actually ran warmer (surface temperatures)."

"We're convinced that by using the new valve system for greater evaporator efficiency, they can increase the suction set point from 40 psig to 43 psig," Victorino says. "That means energy savings will be a direct result of greater coil capacity, resulting from less compressor run time."

Michael E. Hartwig, vice president, Cooling Equipment, Chicago, says his technicians installed the new valve at Open Kitchens Inc., Chicago, which makes ready-made meals. Ice buildup in its freezer was an ongoing problem.

"The freezer door at the facility is open continuously from 5 to 9 a.m., during which nearly 20,000 meals come out of their freezer," Hartwig says. "We have had coil icing problems, requiring a thorough evaporator thawing about every three months, despite the four 45-minute electric defrosts at a current draw of 96 amps (three-phase). The customer now needs just two defrosts each day for only 10 minutes."

The ice buildup problem was solved and money spent on electric defrosts was returned to the bottom line. Because the storage cooler is set to run colder, the customer will see a colder box and better product quality, Hartwig says.◆

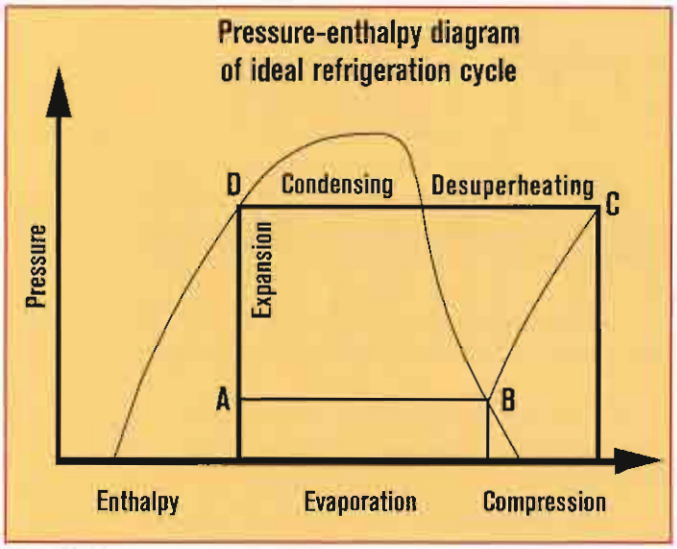

Figure 1.

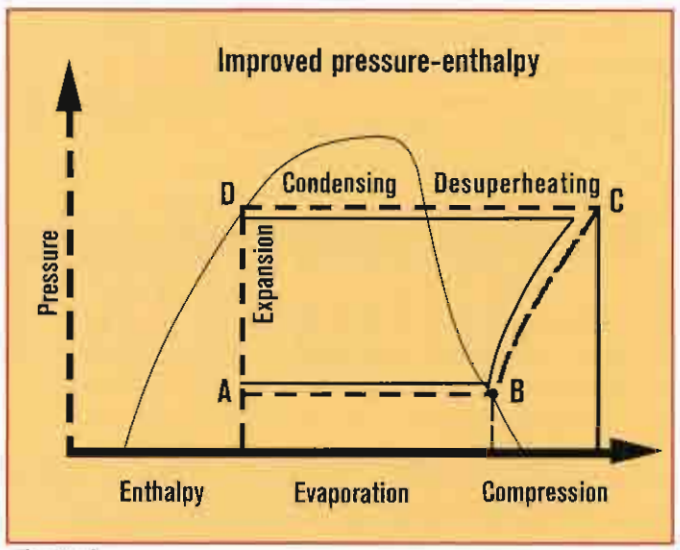

Figure 2.

mates during the off cycle. The improved heat transfer allows for shorter run cycles and longer off-to-run relationships, allowing for greater periods where sublimation is possible.

How the system saves energy

The answer to this savings and improved performance is identified in the heat transfer cycle. Ideally, these systems operate by passing liquid refrigerant through an expansion valve, with some of the liquid flashing to vapor in an adiabatic process. Figure 1 shows the pressure-enthalpy diagram of an ideal refrigeration cycle.

The expansion of the refrigerant is shown as process D-A. The liquid-vapor mixture then enters the evaporator coil. As the cold refrigerant absorbs heat from the case, additional refrigerant is vaporized at constant pressure (A-B).

By the time the refrigerant reaches the end of the evaporator coil, the last of the liquid refrigerant should just be vaporized. The gas-phase refrigerant then goes to the compressor (B-C), which raises the pressure. The hot gas then goes to the condensing coil, where heat is rejected (C-D).

Strategically changing the vapor fraction and flow regime of two-phase refrigerant entering refrigerant-to-air evaporators can significantly increase heat transfer performance. Compressor run-time often is reduced because the rate of heat transfer increases. Suction pressure is usually 1½ to 2 pounds psi higher while maintaining better evaporative temperatures.

Figure 2 shows that improved heat transfer between A and B results in an elevated evaporative pressure. A reduction in superheat as the cycle approaches B impacts efficiency as less desuperheating is required prior to condensing between C and D. Additional subcooling often results at D due to this reduction in condenser heat. Lower compression-ratio between B and C often is a result of using the new valve product.

Lower compressor superheat reduces the desuperheating load in the condenser. The combination of higher suction pressure and lower high-side pressures and temperatures improves overall compressor coefficient of performance (COP). The result is a net capacity increase.

System performance can easily be gauged by the amount of time necessary to do a required amount of work. Factors that improve heat transfer coefficient also improve the heat transfer rate, which in turn can absorb heat from the load at an accelerated level. Faster cooling results in reduction of compressor run time and compressor kwh, while it also provides for more consistent temperatures in the conditioned space.

The retrofit from a conventional DX system to the more efficient evaporative system is applicable in many different facets. Results are showing improved performance on the order of at least 15 percent reduction in compressor run time, with markedly better results as applications are pushed to extremes.

One such result is that humidity is affected in a positive manner. By leaving more moisture in the air, not only are defrost requirements and infiltration reduced, but the refrigerated product is subjected to less moisture loss compared to a DX system.◆

David A. Wightman is president and CEO of XDX. Wallace "Doc" Emmert, sales consultant, is working on the implementation of XDX technology in projects with Pacific Gas and Electric and other energy-related grant programs throughout California. For more information call, 800-XDX-0250 or visit www.xdxusa.com.