CCN
CLIMATE CONTROL NEWS
October 2002

X-Stream technology adds to direct expansion

Since the introduction of the thermostatic expansion (TX) valve in the 1940s, direct expansion (DX) has been the industry's primary refrigerant-feed method. A new valve from US company XDX Innovative Technology, now available in Australia, promises to improve refrigerant flow characteristics. XDX's *Jamie Creer* explains.

Jamie Creer is the sales manager with XDX Innovative Refrigeration, which is bringing its new technology to Australia.

The refrigeration industry is quite diversified and each segment has its own focus and requirements. Bakeries, meat processors, and produce growers are dramatically affected by the dryness of the conditioned air as a result of the refrigeration process.

Profits within the processing industries are often closely related to the responsiveness of the cooling equipment. Control is important to the wine industry as refrigeration requirements range from low load "cold-stabilisation" to the high load exotherms during harvest.

However, several things are common among all refrigeration systems. The desire for reliable system performance, improved product quality, and reduced energy costs are shared by every end-user and affect the bottom line of every business.

XDX Innovative Refrigeration is a U.S. company that focuses on evaporator efficiency through new technologies that improve the refrigerant flow characteristics. XDX Australia/New Zealand has been established to introduce these efficiencies.

XDX's X-STREAM and A.R.M.E.D. technologies have been used in over 2,000 locations to achieve significant product improvements and energy savings.

Direct expansion

Since the introduction of the thermostatic expansion (TX) valve in the 1940s, direct expansion (DX) has been our industry's primary refrigerant-feed method. Direct expansion has various limitations with regard to efficiency, since portions of the evaporator coil are operated with less than optimal heat transfer.

While the last few years have seen the development of a few air-side improvements, 'super sub-coolers', and rifled tubing, as well as improvements to the electronic expansion valve (EEV) to improve coil performance, the fundamental issues with inefficiency remain.

As shown in the CARNOT Cycle (Figure A), the conventional DX system has fair heat transfer between E-1 and E-2, with the center portion of the evaporator between E-2 and E-3 having fair to very good heat transfer, depending upon the evaporator design and application.

The evaporator coil in a large portion (E-3 to E-4) near the refrigerant outlet from the coil is superheated and has almost no heat transfer and has no latent capacity. The superheated vapour then enters the suction line (S) and then the compressor inlet (C-1) where it is compressed, adding more heat in the process.

Exiting the compressor (C-2) as a hot, high pressure superheated vapour, the initial portion of the condenser (DS-1 and DS-2) must be dedicated to de-superheating the refrigerant, and to removing the heat of compression before condensation and sub-cooling (SC) can take place.

The refrigerant then drops in temperature and pressure through the TXV and enters the coil at E-1. Additional sub-cooling is often achieved, which moves the points at SC and E-1 to the left, providing more enthalpic capacity, but lengthening the fair heat transfer area between E-1 and E-2.

Altering vapour fraction

Studies of numerous refrigeration systems operating with the X-stream technology to alter the vapour fraction and flow regime of refrigerant passing through an evaporator has allowed for a new theoretical model, as indicated (Figure B).

The results repeatedly show that better quality refrigerant in the initial few passes (E-1 to E-2) of the evaporative coil can increase stability throughout the coil (E-2 to E-3) and even allow for a greatly reduced evaporator superheat, and eliminating the area between E-3 and E-4.

This allows for entry to the compressor (C-1) with less superheat and less de-superheating upon exit from the compressor (C-2). The greater usable evaporator surface allows for better heat transfer and a higher evaporator pressure.

The reduced superheat provides lower head pressure and temperature when using the same condenser because there is less heat to be removed. The compression ratio between C-1 and C-2 is also reduced. All of this combines to reduce kW and kWh.

Also demonstrated is improved heat transfer coefficients and redistribution of frost on medium and low-temperature air-cooling coils which permit longer periods between defrost cycles, even to the point of elimination of the need for defrost requirements.

Frost forms more uniformly across the entire evaporator instead of 'bridging' between the fins in one concentrated area.

Bi-phase refrigerant flow

The XDX device 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.

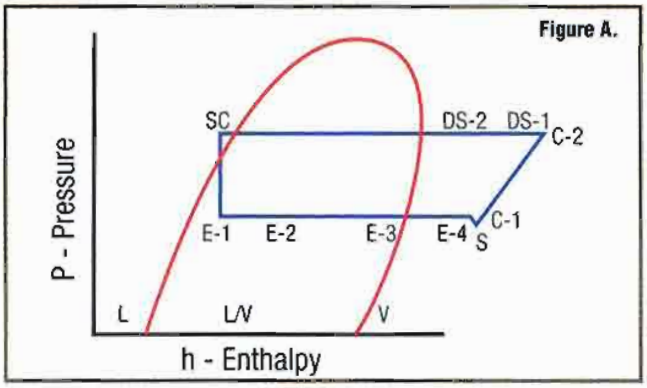
A system using this valve provides turbulent bi-phase refrigerant flow at the evaporator coil. Since the heat transfer has improved, the refrigerating portion of a refrigeration cycle is reduced, with more rapid temperature achievement.

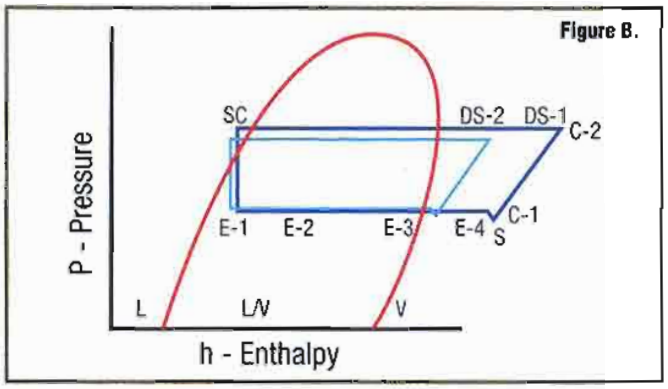
Because the coil, with the new valve in place, is at a more uniform temperature, without the excessively cold flooded portions in conventional coils, frost build up is dramatically reduced.

While 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 sublimates 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.

Underwriter Laboratories quantified the XDX improvement as providing





between 15 per cent and 24 per cent energy savings. This refrigeration valve, from XDX, offers both increased evaporator coil and full system performance of any DX system, whether installed with replacement or retrofitted equipment.

Case study

Jim Eisenberg is the co-chairman of Vienna Sausage Manufacturing Co. of Chicago, Illinois. The processing facilities operated by Vienna have struggled with the effects of moisture removal by the industrial refrigeration equipment and the negative effect of product weight loss upon consistency and profitability.

"Last year, under the auspices of the Department of Commerce of the State of Illinois, our bakery division, Pied Piper, installed the XDX system in its blast freezer," Eisenberg said.

The program was a venture designed to reduce energy within the business community. While the effort successfully reduced kW and kWh, additional unexpected results were even more significant.

"We had problems with the evaporators in the blast freezer becoming a solid block of ice every 10 to 12 days," Eisenberg said. "The bakery was forced to shut down the freezer to clear frost from the box and to defrost the evaporator ice build-up. The product dried out on the surface as the refrigeration system operated. The evaporators frosted frequently and despite the six defrost periods each day, we would have to shut it down for two days every other week because all of the moisture that was drawn out of our product was building in the cold room and on the coil."

Oil return was very poor and temperature recovery was slow since the bakery had the practice of using the freezer to cool off and freeze 140°F product. Machinery wear and maintenance costs were high due to the icing, high load and recovery issues.

"After we installed the XDX system our problems melted away," Eisenberg said. "We now defrost each day for 30 to 50 minutes; we never freeze the coils. The cakes shrink just half a per cent instead of one and half per cent, thus our product retains its moisture in the surface. The one per cent product weight improvement went straight into our profits. Best of all our electrical usage has gone down 25 per cent on average."

Enquiries, 02 8338 9499.