## A Secondary Coolant Progress Report:

# IT'S GREEN! IT IMPROVES PRODUCT QUALITY! IT SAVES MONEY!

***You can help customers reduce installation costs, lower operating costs, and lessen refrigerant charges and emissions potential by introducing them to secondary-coolant refrigeration systems.***

by CB Staff

Integrated, secondary coolant refrigeration systems were introduced into supermarkets in 1996. The applications include complete low and medium temperature store cases, walk-ins, prep rooms, and the chiller for HVAC systems. Now, with more than 160 system installations in more than 16 major chains, there are sufficient data to see if the promise is being fulfilled.

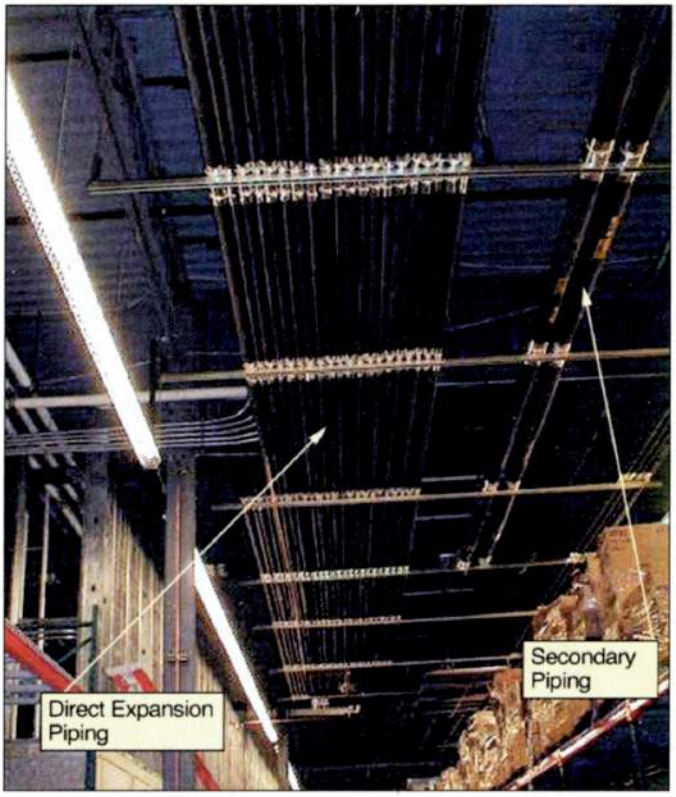
Simply stated, secondary coolant systems will provide:

- Reduced refrigeration system complexity
- Lower system installed cost
- Lower annual maintenance cost
- A significant reduction in refrigerant charge
- Annual energy cost savings
- Improved product quality
- Automatic code compliance
- Environmental soundness/it has green acceptance.

In looking at the performance data to date, a properly designed secondary coolant system for supermarkets is very competitive with direct expansion systems (DX). It's the additional advantages that justify its purchase.

By definition, coolant is the fluid used for transferring heat from one source to another. The primary coolant is the fluid used to lower the temperature of a secondary coolant, usually a refrigerant. The secondary coolant is the fluid used to transfer heat from a heat source to a primary coolant, typically not involving a change of phase. Secondary coolant technology involves all aspects of design. These include:

- System design
- Case redesign, testing, and development
- Secondary coolant selection, testing, and development
- Materials, equipment, and devices
- Control strategies
- Energy conservation




***This photograph shows the dramatic reduction in piping requirements between direct expansion and secondary coolant refrigeration systems.***

### Reduced Complexity

Here's how secondary coolant systems are delivering on their promise.

The primary system is simplified with a negligible primary refrigerant pressure drop. The evaporator is close to the primary system, coupled with the compressor system, not 200 to 400 ft. from it as required with a conventional system. There's only one evaporator per rack containing 100 to 300 lbs. of refrigerant *versus* the 1,000 to 1,500 lbs. per rack found in conventional systems. The smaller amount of primary refrigerant stays in the mechanical center circulating through only one small loop at the chiller. There's no primary refrigerant circulating in the store. Also, the lower operating pressure of a secondary coolant system eliminates the stress and leak potential that come with a conventional high-pressure direct expansion (DX) system.

The secondary coolant compressor unit operates with low super heat, which provides a 10% increase in actual evaporator capacity, a 4% reduction in total heat rejection, and a 9.8% improvement in net evaporator energy efficiency rate (EER).

In a conventional system, each cooler or case has a separate thermal expansion valve that requires adjustment. With a secondary coolant system, the need for multiple valves is eliminated, reducing the chance of leaks at connection points, and also eliminating the need for individual valve adjustments.

When you consider that the average supermarket has approximately 42,000 sq.ft. of floor space and about 80 coolers or cases, this adds up to a significant simplification.

### Lower Installed Cost

The initial additional equipment cost for a secondary coolant system is 15 to 35% above that of a conventional system, but this cost is offset through the savings achieved in material reduction and installation labor. Specifically:

- Refrigerant grade copper pipe isn't needed. A 20 to 40% reduction in cost can be achieved using plastic, Vitaulic, or water grade piping
- No special pipe requirements are needed for risers, or traps for oil returns
- No nitrogen flow is required for cleaning or welding
- Vacuum isn't required in loops or branches
- No electric defrost is required on loop systems
- No TXV valve adjustments are needed. The only TXV is at the chiller
- No EPR adjustments
- No high pressure test requirement.

All of the above add up to material, labor, and time savings that help open a new store faster.

### Lower Maintenance Costs

Annual per store maintenance cost savings range from 30% to a high of 46% per year. These savings come from a reduction in the number of connections and valves needing adjustment. System control is simple, and the amount of oil required is significantly reduced compared with a conventional system. A conventional system, for example, will circulate 1,000 lbs. of refrigerant through approximately 4,000 ft. of pipe. This can require 20 gal. of expensive POE oils, while a secondary coolant system will only use 2 to 3 gal. of oil.

An additional benefit of secondary coolant systems is you can handle most service requirements in the machine room, not the store's merchandising areas.

You can also significantly reduce the system's refrigerant charge. Compared with a conventional system, there's a 75 to 85% reduction in the primary refrigerant charge requirement, yielding a major reduction in the emission potential. The secondary coolant fluid, propylene glycol, is 100% environment-friendly with no impact on the ozone layer or on global warming. Plus, it's considerably less expensive than refrigerants.

### Energy Cost Savings

Annual per-store energy cost savings with a secondary coolant system average $7,200 per year. The three factors contributing to these savings are:

- Reduced peak demand yields $4,400 per year
- Savings from lower condensing temperatures during the day yield $1,000 per year
- Ability to achieve a higher EER for shifted load yields $1,800 per year savings.

Energy cost savings in Europe are reported to be less due to a different energy efficient secondary coolant system design. In Europe, their goal has been directed more toward environmental compliance than energy savings. The environment does, however, get hit indirectly because of the higher energy

## KMART GARNERS 7% INSTALLED COST REDUCTION

Kmart introduced secondary coolant technology for medium temperature systems in its Super K stores in 1996. To date, there are 16 of these installations. Low temperature cases will be added once system tests are complete. Kmart's five years of experience with secondary coolant technology has substantiated the following:

■ ***Significant 7% installed cost reduction:***
Compared with a traditional DX system, Kmart's installation costs have dropped 7%. This significant savings includes all equipment, material, and installation labor for a new store. Secondary coolant systems require just one large piping loop for supply and return. DX systems, in comparison, generally require two pipes per circuit: a suction and a liquid line. So, with 15 circuits, 30 sets of pipe are required. Less piping in the store's ceiling translates to less labor. Adding to the cost reduction, plumbing grade copper pipe can be used, instead of higher quality refrigeration grade copper. Simpler installation can also speed new store construction by up to two weeks.

■ ***Better product temperature:***
The secondary coolant coil is flooded, permitting 100% use of the coil surface for heat transfer. DX systems require proper TXV adjustment. Additionally, secondary coolant systems use on-or-off controls, whereas DX systems use evaporator pressure regulators that may need temperature adjustments based on swings in ambient temperatures. This approach allows Kmart to meet the Food and Drug Administration's (FDA) food safety product temperature requirements.

■ ***Addresses environmental issues:***
The effect of refrigerant on the Total Equivalent Warming Impact (TEWI) index is a major concern. Recent independent studies confirm that secondary coolant systems are environment-friendly. The potential for refrigerant leaks that affect the ozone layer is greatly reduced. The primary refrigerant charge is reduced by 60%, which yields a significant cost savings. Conventional DX systems will use 4,000 to 5,000 lbs. of refrigerant *vs* 1,800 to 2,000 lbs. for a medium temperature secondary-coolant system. This savings is included in the initial 7%.

■ ***Uniform Fire Code compliance***
The Uniform Fire Code requires no more than 9.4 lbs. per 1,000 cu.ft. for R-22. Should that limit be exceeded, audible and visible alarms tied to the fire monitoring system are required. Should there be a refrigerant leak, the fire department is called and the building evacuated. With secondary coolant, only a mixture of water and antifreeze is circulating, hence automatic code compliance. With some DX systems, local code compliance has been reported to cost from $25,000 to $100,000 due to the installation of necessary leak detection devices and fire monitoring system.

### The Future

Kmart sees secondary coolant systems becoming the standard for low and medium temperature cases in its stores. The benefits and payback are there. The real key to success, Kmart points out, is to start with a well-designed system.

requirements of the design.

There's also improved product quality with secondary coolant systems, since the ability to control product, not just case temperatures, is more stable and compliant. This is because defrost time is equal to or less than what it is with hot gas defrost systems. In addition, there's reduced recovery time. The result exceeds the Food and Drug Administration's (FDA) 41F product temperature requirement. An important additional advantage to your customers is improved product quality, due to less shock and moisture removal, which, in turn, yields longer shelf life.

Code compliance is assured because secondary coolant systems meet the scrutiny of the uniform building and fire codes, and are compliant with ASHRAE Standard 15 in the Uniform Codes. The cost to supply information relative to refrigerant leakage with a conventional system can range, depending on location, from $25,000 to $100,000 per store as more municipalities begin to require code compliance. Upfront compliance with the FDA product temperature requirement yields additional compliance savings.

### Green Acceptance

Many chains now have international ownership. As such, secondary coolant systems are preferred internationally, especially in the Scandinavian countries that have been very proactive relative to ozone depletion and global warming. It's important for these firms to be portrayed, both here and abroad, as companies that care about the environment, energy efficiency, and product quality. In some European countries, R-22 has already been banned and use has switched to ammonia or $CO_2$ as primary refrigerants. On the secondary coolant side, they're using a variety of products.

System reuse is another benefit of secondary coolant systems. Since they're far less complex (fewer components) than direct expansion (DX) systems, some supermarket chains are discovering that a system can be removed and refurbished by the manufacturer should a store close. The refurbished system can then be sent to a new store site. Again, there's an additional savings.

Early on, however, increased energy consumption was considered a disadvantage of secondary coolant systems. Not only was there an additional heat transfer step that required compressors to operate at lower suction temperatures, but it added energy and load for secondary fluid pumps and load for increased line losses.

Other assumed disadvantages included additional equipment and the cost for heat exchangers, pumps, expansion and defrost tanks, insulation for secondary coolant piping, and needed space for this equipment.

To address these concerns, new methods were developed that reduce the energy penalty disadvantage. These changes include lower compressor suction gas temperature, increased secondary coolant fluid temperature, warm fluid for defrost using heat reclaim, and new piping insulation technologies. The result is that a properly designed secondary coolant system for supermarkets can be competitive with DX systems and provide the many advantages outlined in this article. CB

EDITOR'S NOTE: *Information for this article was supplied by Hill Phoenix, Conyers, GA. Contact the company by calling 770/285-3261, or visit its website at* ***www.hillphoenix.com****.*