

SUPERMARKET REFRIGERATION SUPERHEAT OPTIMIZER SYSTEM

The superheat optimizer system (superheat sensor system) offers a practical solution to common and often overlooked refrigeration problems and significantly improves the performance and efficiency of supermarket refrigeration systems. The system was developed and patented by Super S.E.E.R Systems Inc. One of the main causes of inefficiency in supermarket refrigeration systems is the lack of attention paid to superheat control and the resulting negative energy penalties and overall system ramifications. The superheat optimizer system directly addresses these problems and the industry need to focus on operational and cost efficiencies. The system is ideal for low & medium temperature cases and walk-in boxes.

SYSTEM BENEFITS

Superheat optimizer system value added benefits:

- Faster and more accurate valve setup
- Stable system operation at low superheats/reduced TDs/increased suction pressure
- Reduced compressor run times
- Steady TXV control = constant discharge air temperatures
- Faster pull-down
- Fully flooded coils frost evenly resulting in faster defrosts and improved airflow
- Reduced retail product shrinkage and shock
- Improved product integrity, appearance, longer shelf life
- Improved oil management
- Reduced system maintenance costs
- Increased cooling capacity and system efficiency
- Utility savings and improved net bottom line

COMMON PROBLEMS FACING SUPERMARKET REFRIGERATION SYSTEMS

Improper superheat control results in the evaporator not being fully flooded and active at all times, due to the fact that the thermostatic expansion valve (TXV) is hunting and not maintaining steady superheat control. The unnecessarily large area of the coil used for superheat renders this area practically ineffective for heat transfer. As the TXV hunts, the result is a partial emptying and refilling of the evaporator coils with liquid refrigerant, which can lead to a reduction in cooling capacity of up to 35%.

The TXV bulb, sensing the temperature of the suction gas at the evaporator outlet, controls the flow of liquid refrigerant into the evaporator. This closed loop feedback system control is fine in

theory; however, it encounters numerous problems in actual operation. One of the main problems arises due to unequal loading of multi-circuit evaporators, with the least loaded circuit dictating the control of the TXV. This results in a greater amount of vapor and less liquid, thereby significantly reducing system capacity and efficiency.

Other common problems in controlling superheat are due to laminar flow in evaporator tubes and minimal surface contact between the sensing bulb and the suction line. These inefficiencies result in a lag in TXV bulbs sensing refrigerant temperature due to oil coating the inside of the suction line and the barrier effect. Valve hunting results in continuously varying discharge air temperatures. Further complications arise when the liquid refrigerant running in the liquid line that feeds the TXV is exposed to this air stream and fluctuates in the same manner. As the liquid temperature changes, so does the mass flow rate through the TXV.

SOLUTION - SUPERHEAT OPTIMIZER SYSTEM

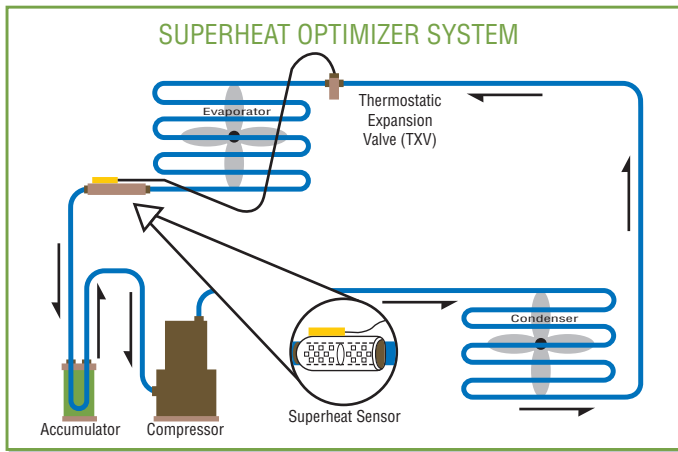
Implementing the patented superheat optimizer system includes:

- installing the superheat sensor at the evaporator outlet
- insulating the liquid line and all components (suction-to-liquid heat exchanger, shut-off valve, dryer, etc.) located in refrigerated areas
- upsizing the TXV, orifice and distributor tubes

SUPERHEAT SENSOR

The superheat sensor consists of two concentric copper tubes. The outer tube is larger and sealed to the inner tube, forming an annular space between the tubes. The inner tube is closed at its mid point and is perforated to allow flow into and out of the annular space. Suction gas flows into the first inner chamber, then out through the perforations, into the annular chamber, then via the perforations, into the outlet chamber of the inner tube, into the suction line and finally the compressor. There are no moving parts and the pressure drop through the superheat sensor is negligible.

The purpose of this contorted flow path is to mix and turbulate the liquid refrigerant component with the superheated vapor portion, causing instant vaporization of any liquid. The turbulence generated in the chamber averages the temperature of the suction gas from multi-circuit coils, resulting in stable and



accurate superheat control, thus fully flooding the evaporator. The TXV sensing bulb is secured to the outer sensor tube. To further assist the superheat reading, a groove is formed in the outer tube, of the superheat sensor, to provide additional thermal contact and ensure perfect alignment of the TXV bulb to the suction line.

IMPORTANCE OF INSULATING LIQUID LINES

Traditionally, most supermarket refrigerated cases incorporate a liquid-to-suction heat exchanger to improve efficiency. Field test readings of liquid line temperatures across various heat exchangers have led to surprising results. It was expected that the temperature of the liquid leaving the heat exchanger would be consistently 10° F to 20° F lower than the entering temperature. However, in testing, the two temperatures across the heat exchanger were almost equal and actuated by up to 25° F in approximately 5 minute cycles. It was observed that the TXV was hunting at the same rate as well. The conventional thinking was that a bare copper liquid line was advantageous, as it produced further sub-cooling of the liquid. However, in actual operation, it was simply passing the heat from the liquid into the refrigerated case and increasing case loads, resulting in no net benefit. The liquid lines running through the case cooled the liquid, significantly reducing the approach temperatures of the suction-to-liquid heat exchanger, rendering it virtually ineffective. This scenario applies to literally thousands of heat exchangers installed in supermarkets across North America and worldwide.

The solution is both simple and straightforward; insulate the liquid line and all components (dryer, heat exchanger, shut-off valve, etc.) that are exposed to the cold case environment with 1/2" armaflex. The results are indisputably proven. Two parallel temperature readings approximately 15° F apart with the TXV controlling perfectly and a constant temperature liquid entering the valve. The suction gas temperature increases by up to 35° F across the heat exchanger.

SYSTEM IMPROVEMENT AND BENEFIT SUMMARY

- Tests have consistently shown that implementing the superheat optimizer system allows for an increase in rack suction pressure of 5 to 7 psig, while maintaining the same case temperatures
- As the coils are running fully flooded at low steady state superheats (set at 3° F to 5° F), heat transfer is dramatically improved, TD's are reduced and uniform coil frosting is achieved. This allows for higher case humidity levels and shorter and more effective defrost cycles, resulting in less retail product shock, reduced shrinkage, improved product appearance and freshness
- **Perishables, in terms of procurement and freshness are a major point of differentiation with supermarket retailers**
- The oversized orifices, distributors and TXVs provide improved control and much faster pull-downs
- The insulated liquid lines and components contribute to greatly enhanced suction-to-liquid heat exchanger performance as well as providing a constant temperature liquid to the valve
- By fully activating / flooding the evaporator, the amount of oil trapped in the evaporator coil is reduced; further aiding heat transfer and improving oil management
- Uniform frosting results in improved airflow and less problems with case icing
- **Addresses the supermarket industry need to focus on operational and cost efficiencies**

The product benefits are just as or possibly even more important, financially, to the supermarket as are the energy savings realized by installing the superheat optimizer system. The superheat optimizer system has been successfully installed and implemented on both new and retrofit installations, in hundreds of supermarkets, since 1997.

OTHER APPLICATIONS

The superheat optimizer system applies specifically to refrigerated display cases (low and medium temperature) and walk-in boxes. Superheat sensor applications include:

- sub-coolers
- chillers
- HVAC
- any product requiring a TXV
- blast freezers

