Destructive Superheat in Supermarkets

By Sporlan Valve Company Supermarket Application Group

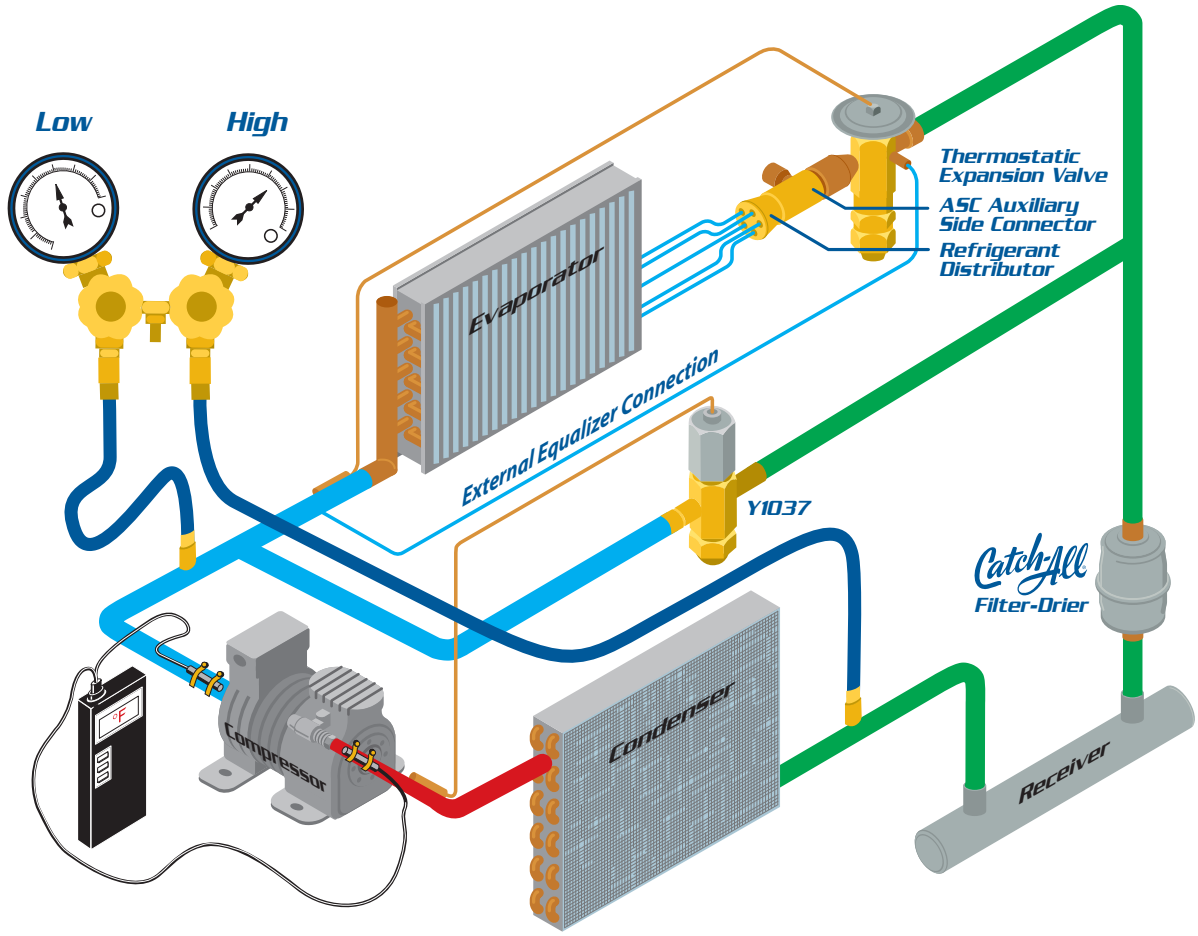
The majority of compressor failures on low temperature refrigeration applications originate from overheating. The largest percentage of those failures could be eliminated if the compressor discharge superheat was reduced to reasonable levels. Compressor design, in recent years, has improved achieving an inherent reduction in compressor temperature on specific applications. These design improvements fall into several areas, such as reduced contact between the motor and compressor housing; improved motor design; reduced volumetric clearances due to improved machining tolerances; and minimizing heat transfer between the high and low pressure areas of the compressor. Although these improvements have significantly reduced compressor temperature, desuperheating the return vapor in many applications can add years to the compressor service life.

Compressor capacity rating data is based on the industry standard of a 65°F return vapor temperature. The 65°F return vapor may be satisfactory for compressors operating in medium temperature applications. However, on low temperature applications, the decreasing vapor density and increased compression ratios combine to create high discharge temperatures. Ring and piston wear begin to accelerate rapidly when the cylinder wall temperature reaches 300°F or higher, according to some compressor manufacturers. Compressor lubricant viscosity decreases as temperature increases. Additionally, field experience has shown lubricant decomposition occurs when compressors operate at an elevated temperature. The lubricant decomposition is accelerated by residual contaminants that are present in a typical system. The process ultimately causes a decrease in lubricity as well as chemical reactions harmful to the system.

Compressor discharge line temperature six inches from the compressor body is the reference point to determine the internal cylinder wall temperature. The number of degrees the temperature drops from the cylinder to the discharge line is variable depending on the type compressor. Manufacturers of semi-hermetic compressors place the temperature of the cylinder walls somewhere between 50 and 75°F warmer than the discharge line (depending on the model). To determine the specific temperature drop for a particular application, the compressor manufacturer should be contacted.

The proper discharge temperature can also be determined by controlling the suction superheat entering a compressor. A set of manifold type gauges can be installed between the liquid line and the suction line. The suction line connection should be at least 24 inches before the compressor. A thermometer should then be installed six inches before the compressor on the suction line and six inches away from the compressor on the discharge line. The gauge manifold is then used to meter refrigerant into the suction line dropping the superheat to the recommended value for the application. The thermometer on the discharge line should be monitored until the temperature stabilizes. This may take up to 2 hours. When the discharge line thermometer stabilizes, the temperature indicated is the proper discharge temperature for the application.

Figure 1



The examples listed in Table 1 are typical supermarket applications that may require desuperheating to prevent shortened compressor life.

Note: The discharge line temperature in Table 1 is based on an 85°F vapor temperature increase over the semi-hermetic compressor motor windings.

One of the most cost effective methods of preventing destructive superheat at the compressor is the use of a Temperature Responsive Expansion Valve. Sporlan Y1037 TREV modulates the flow of refrigerant into the suction line ahead of the compressor in response to the temperature of the discharge line. The valve does not have an equalizer line, and is not influenced by pressure. A sensing bulb is placed on the compressor discharge line six inches from the compressor body. The temperature setting is available from 115°F through 275°F. A bellows assembly is used similar to a bellows in a direct acting pressure regulating valve. The element is charged with a hydraulic fluid which expands as its temperature increases. Different capacities are offered with a maximum nominal five ton capacity for R-22 and three tons for R-507 and R404A.

Installation: A liquid supply line to the TREV should be connected to a high side location that will provide vapor free liquid to the valve. The TREV should feed directly into the compressor suction line 12 to 18 inches before the compressor. Other locations are possible, and the suitability of these locations should be determined by testing and evaluation.

TREVs can also be used on compound low temperature applications to supplement the economizer when the subcooler load is light. The TREV is then piped to feed directly into the interstage piping for each compressor on the high stage. A TREV has a positive shut off and a solenoid valve is typically NOT required. Good thermal contact between the sensing bulb and discharge line is essential. Additionally, insulating the bulb with a high temperature insulation such as fiberglass or equivalent is recommended.

Today, commonly used refrigerants in supermarkets such as R-507 and R404A are known as "cooler" refrigerants (compare R-22 temperature above). However, destructive superheat, due to the higher condensing temperatures common in many geographical areas of the United States during the summer, is taking its toll on the operating lifetime of compressors.

Table 1

Saturated Suction Temperature	Condenser Temperature	Liquid Temperature	Suction Vapor Temperature	Evaporator Load BTUH	Discharge Line Temperature	Cylinder Wall +75°F
R-404A						
-25	110	100	65	30000	243	318
-25	120	100	65	30000	253	328
-30	110	100	65	30000	249	324
-30	120	100	65	30000	259	334
R-507						
-25	110	100	65	30000	237	312
-25	120	100	65	30000	247	322
-30	110	100	65	30000	244	319
-30	120	100	65	30000	253	328
R-22						
-25	110	100	65	30000	313	388
-25	120	100	65	30000	327	402
-30	110	100	65	30000	324	399
-30	120	100	65	30000	338	413

SPORLAN VALVE COMPANY
206 LANGE DRIVE • WASHINGTON, MO 63090
636-239-1111 • FAX 636-239-9130
www.sporlan.com