Electronic Control Of Liquid Subcoolers

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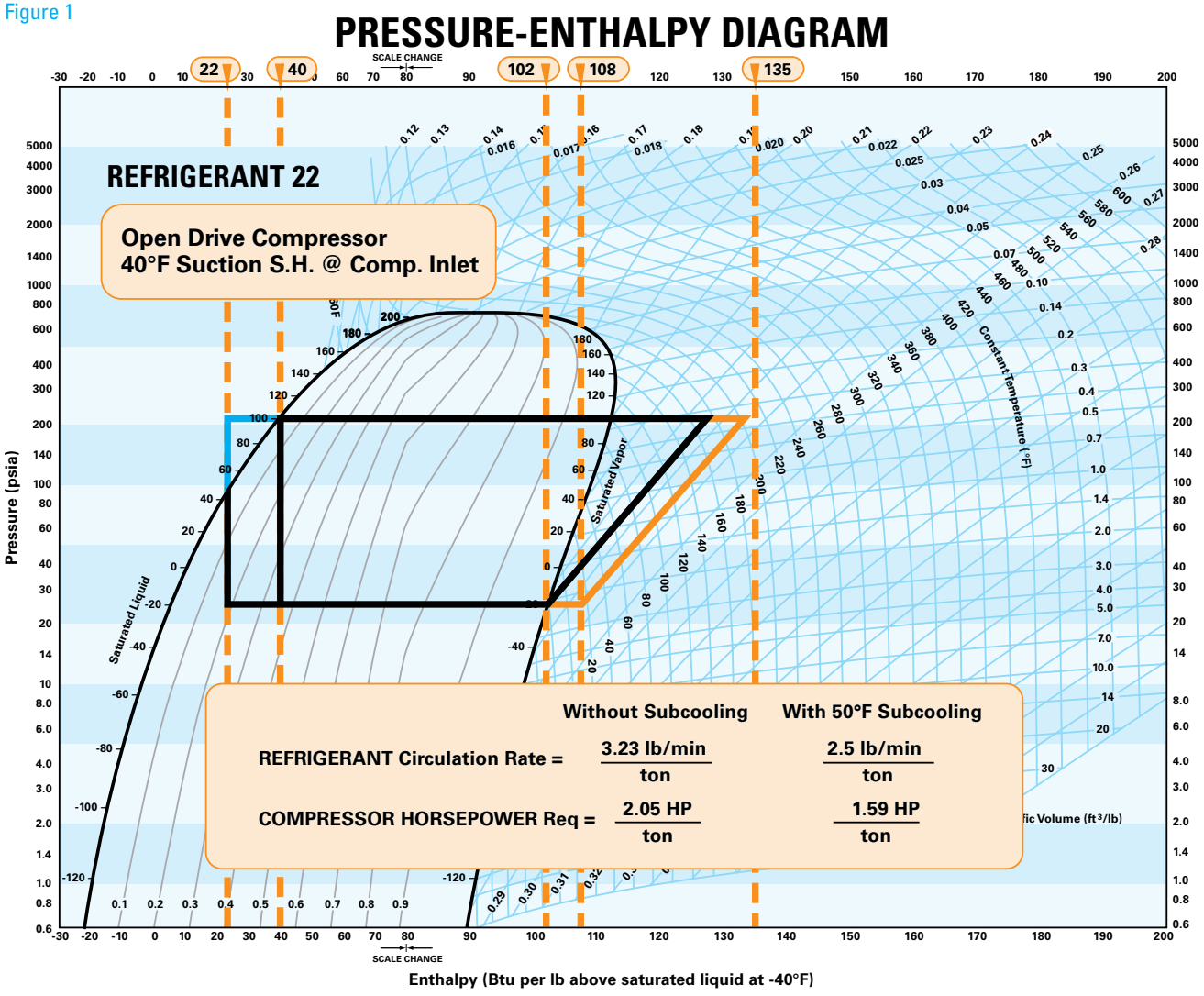
The physics that produce the increased efficiency of the refrigeration cycle due to liquid subcooling have long been understood; the Presssure-Enthalpy (Ph) diagram in Figure 1 illustrates this increase.

Supermarket refrigeration, because of its constant need for operation and high energy usage has always attempted to make use of this fact. The first attempts were simple: soldering the liquid line to the suction line or running the liquid line through the refrigerated cases. Although easy enough, the effects and benefits were hard to predict or quantify.

A number of years ago, mechanical subcoolers began to be used in supermarkets. These systems were, and are, generally used to subcool the liquid supplied to the low temperature system. Since the most energy savings result from increases in efficiency of the low temperature circuits, this certainly makes the most sense. In practice, the subcooler is run as another circuit on the medium or high temperature rack. Please refer to the illustration of the heat exchanger in Figure 2. Liquid from the receiver (A) is piped through a heat exchanger and the resulting subcooled liquid (B) is supplied to the liquid header of the low temperature rack. The cooling of this liquid is accomplished by feeding liquid from the medium temperature rack into the evaporating side of the subcooler heat exchanger (C). This liquid is controlled by an expansion valve or valves, and evaporated in the heat exchanger in the normal manner. The vapor (D) is returned to the suction header. In some instances, evaporator pressure regulators (EPRs) are used to attempt to maintain a set liquid temperature.

These mechanical systems have been successful in saving energy, but actual control has always been problematic. The temperature of the liquid from the condenser or receiver can vary widely with changes in ambient, fan cycling, condenser cleanliness and demand from the system. Variations in liquid temperature supplied to the display cases can lead to hunting of the expansion valve, and poor performance.

Figure 1



To address these problems, a variety of systems have been used. Changes from shell-in-tube heat exchangers to brazed plate heat exchangers have increased the system's ability to create subcooled liquid. The changes in liquid demand, heat pressure and receiver liquid temperature have been addressed by adding staged expansion valves, solenoids, and EPRs. The systems have become very complex but are still widely used in supermarket refrigeration.

Recently, Sporlan applied its expertise in electronic superheat and chiller control to the problem. The humorously named Subcool-O-Matic provides a level of performance that is very serious. The system consists of an Electric Expansion Valve (EEV), a controller, a pressure transducer and two temperature sensors. Figure 2 is a schematic of the basic installation.

In practice, the controller gathers pressure and temperature data from the pressure transducer and temperature sensor mounted on the suction line of the heat exchanger. This data allows the controller to calculate superheat. This superheat level is monitored to prevent floodback to the compressor. The primary function of the Subcool-O-Matic is to control the subcooled liquid temperature supplied to the liquid header. The second temperature sensor is strapped to the outgoing subcooled liquid line and the controller modulates the EEV to meet the programmed setpoint. Both superheat and liquid temperature are user chosen, but are often defaulted to 40°F liquid and 10° superheat.

Because of the ability of the EEV to operate precisely over wide load conditions, only one is required instead of the multiples sometimes needed in mechanically based systems.

Figure 2

Subcooler Controller Wiring Schematic

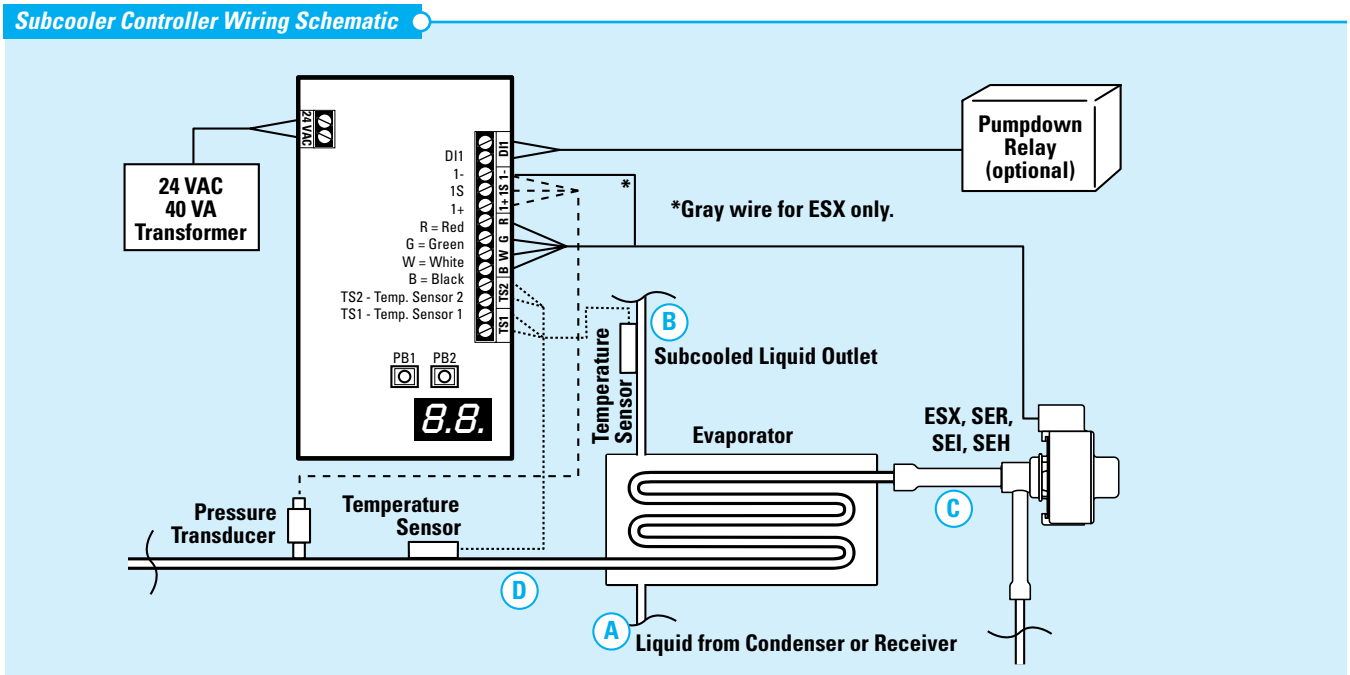


Figure 3

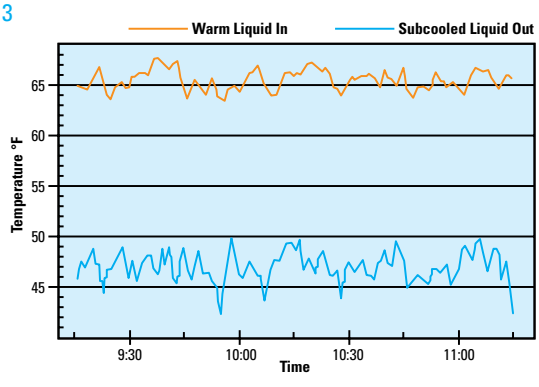


Figure 3 shows a graph of subcooled liquid control possible with the Subcool-O-Matic. The units can be set for a variety of refrigerants and have been used in a number of supermarkets.

Existing units are standalone and can be retrofitted to help solve system problems. In the future, integration into the rack controller is likely.

Electronic controllers and electric valves continue to provide increases in control, simplicity and energy efficiency, and Sporlan is leading the way.

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