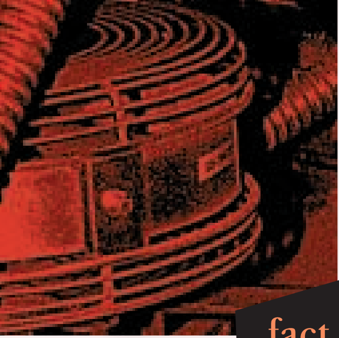

Evaporative Condenser Control

Techniques to cut energy waste in large refrigeration systems

fact sheet

Proper condenser head pressure control can save energy in large refrigeration systems. Research at the University of Wisconsin suggests that the optimal condenser head pressure is a linear function of outdoor wet-bulb pressure. Computer modeling suggests that energy savings on the order of 10% is achievable, even in already efficient systems.

EVAPORATIVE CONDENSER SIZING

Evaporative condensers in ammonia refrigeration systems are typically sized to provide a system saturated condensing temperature/pressure of 95ºF/180 psig at design outdoor wet bulb conditions. An oversized condenser (system saturated condensing temperature/pressure of 85ºF/152 psig) will allow the system to operate more efficiently by reducing the required compressor power. In addition, the condenser fans may also require less energy if they are properly controlled.

The larger evaporative condenser will cost more initially but may pay for itself in reduced operating costs. Simulation results indicate that controlling the evaporative condenser to maintain a saturated condensing temperature of 85ºF will reduce power consumption by 3% to 4%, compared with operation at 95ºF.

HEAD PRESSURE CONTROL

Refrigeration systems commonly use fixed head pressure control. In these systems, a setpoint head (condensing) pressure is maintained regardless of the system load by controlling the condenser fan operation.

It has been well-established that allowing evaporative head pressure to “float” down to a minimum pressure will save energy. Energy is saved because the compressor does not have to work as hard at lower head pressure. Even floating head pressure systems, however, need a minimum head pressure to operate reliably. In some systems, this minimum is dictated by the characteristics of the thermal expansion valves, which require a minimum pressure drop in order to correctly meter refrigerants. Valve manufacturers provide information on the minimum allowable pressure drop.

In other systems, minimum head pressure is dictated by the hot-gas defrost circuit. In this case, the minimum head pressure is a function of the size and length of the hot-gas bypass circuits as well as the peak hot gas demand. In most situations, the minimum head pressure required for reliable operation is lower than the setpoint used in fixed head pressure control. For conventionally sized condensers, allowing the pressure to float to the minimum will minimize system energy use.

Optimal head pressure control is more complicated for oversized condensers. Research at the University of Wisconsin determined that optimum head pressure is only weakly dependent on evaporator load. Rather, it is dependent on the evaporative condenser and compressor characteristics and is an almost linear function of outdoor wet-bulb temperature.

DETERMINING OPTIMUM HEAD PRESSURE CURVE

Use the following procedure to determine the optimum head pressure curve. This procedure should be done during off-design periods of the year, when the outdoor wet bulb temperature is relatively low.

1. Measure the outdoor wet bulb temperature.
2. Note the condensing pressure and system electrical demand.
3. Reset the condensing pressure down 5 psig (35 kPa) and allow the system to equilibrate. For this procedure to be successful the system must be operating at steady conditions.

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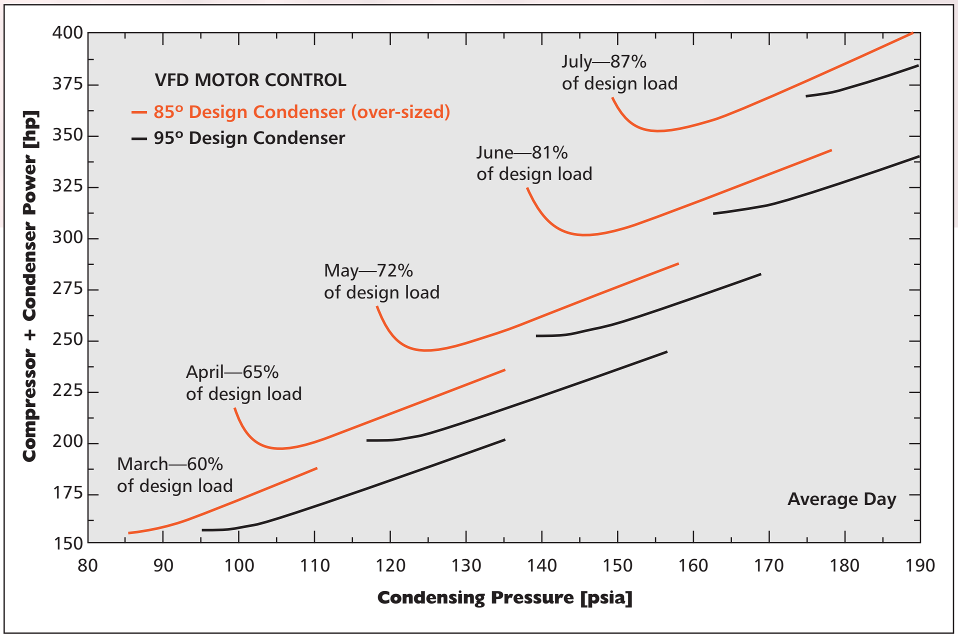
4. Note the new system electrical demand.
5. Repeat steps 3 and 4 until the condensing pressure lower limit is reached. The lowest pressure possible will depend on expansion valve limits or the need for hot gas defrost, as noted above.
6. Plot the system electrical demand vs. the condensing pressure and note the condensing pressure that corresponds to the point of minimum system electrical demand (see example in Figure 1).
7. Plot that pressure on a curve of optimum condensing pressure vs. outdoor wet bulb temperature.
8. Repeat steps 1–7 on one or more days with different wet bulb conditions to develop a curve similar to Figure 2. Steps 1–7 need to be executed in a short period of time (1–2 hours) because the outdoor wet bulb temperature will change throughout the day.

A programmable logic controller (PLC) or supervisory controller can be used to maintain optimum system performance throughout the year.



(Figure 1) **Minimum system electrical demand as a function of condensing pressure.**

LEARN MORE

Find out more about performance optimization of industrial refrigeration systems:

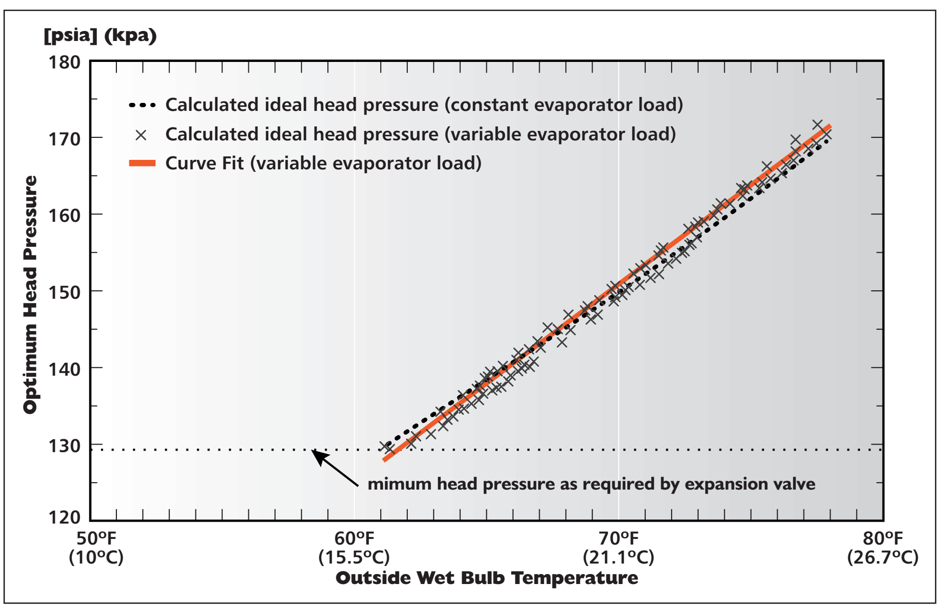
Cutting Energy Waste in Large Refrigeration Systems. 1999. Energy Center of Wisconsin fact sheet. Available at www.ecw.org.

Evaporator Condenser Control in Industrial Refrigeration Systems. 2000. By Kyle A. Manske, Douglas T. Reindl, and Sanford A. Klein. Submitted for publication in the International Journal of Refrigeration.

Load Sharing Strategies in Multiple Compressor Refrigeration Systems. 1999. By Kyle A. Manske, Douglas T. Reindl, and Sanford A. Klein. Presented at the 8th International Refrigeration Conference at Purdue University, July 2000.

Performance Optimization of Industrial Refrigeration Systems. 1999. Master's thesis by Kyle A. Manske. University of Wisconsin, Madison. Energy Center of Wisconsin publication 196-1.

Refrigeration System Malfunctions (Monitoring to Prevent Problems). 1999. By Kyle A. Brownell, Sanford A. Klein, and Douglas T. Reindl. ASHRAE Journal, February 1999. Available on-line at www.ashrae.org.



(Figure 2) **Optimum head pressure setpoints as a function of wet-bulb temperature show an almost linear relationship.**

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The Energy Center of Wisconsin is a private nonprofit organization dedicated to improving energy efficiency in Wisconsin. With support from Wisconsin's energy utilities, ECW provides energy efficiency programs, research, and education to residents, businesses, and government.

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