Chilling Savings with HYBRID CONDENSERS

Big Y Supermarket in Southwick, MA, achieves dramatic increase in peak ambient cooling capacity and lower energy use with the installation of a hybrid condenser.

BY MARC SANDOFSKY

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In an effort to mitigate the inefficient and failing performance of an older air-cooled condenser, Big Y in Southwick, MA, made a decision to replace it with a “hybrid” condenser. Recent heat waves had made changing the condenser a necessary upgrade.

“In this age of heightened environmental awareness, Big Y is continuously striving to positively impact the planet,” said Director of Facilities Tony Coppola. “We were attracted to the [hybrid condenser] because of the promised energy savings and capacity increases. The Southwick installation validated those expectations. It’s also of great importance, however, that the [unit] allows us to reduce the amount of refrigerant in the system, and that the [condenser] can be recycled at the end of its useful life. Benefits like this can only help us to make a more positive impact in the communities we serve.”

In addition to utility incentives, hybrid condensers offer several benefits when compared with their air-cooled and evaporative cousins. Compared to air-cooled units, the benefits are: reduced weight and footprint; reduced energy consumption; and improved plant COP (lower condensing temperatures). Compared to evaporative cooling units, the benefits are: no risk of Legionella; no registration required; no need for water treatment; reduced water consumption by up to 80%; and increased life expectancy for the unit.

Big Y is served by three air-cooled rack systems that run on R-404A refrigerant. Rack A is low temperature, and racks B and C are medium temperature. Muller Industries’ 3C hybrid unit replaced an old air-cooled condenser on rack A.

The technology
At its heart, the unit installed at Big Y is an air-cooled condenser that rejects its heat to ambient air drawn by fans across condenser coils (heat exchangers) and back into the
outside ambient air. However, this unit is different from traditional air-cooled systems in a number of ways.

Heat-exchanger coils—The standard horizontal condenser coils have been replaced with vertically mounted aluminum microchannel heat exchangers that allow for increased heat rejection and lower refrigerant charge. Standard coils are manufactured from copper tubes/aluminum fins. The tubes are mechanically expanded into collared holes in the fins to ensure proper mechanical and thermal bonding for effective heat transfer. The coils are a floating tube design. An alternative tube/fin combination is galvanized steel tubes/aluminum fins.

Evaporative pre-cooling—CelPad Type 5090 evaporative cooling pads are used to pre-cool the incoming air. These have been mounted to the outside of the heat exchangers. Under high ambient conditions, water flowing across the pads evaporates into the condenser air—thereby lowering its temperature and increasing heat rejection. To minimize water use, water that is not evaporated is re-circulated over the pads and then flushed to drain at the end of each day. With no standing water, chemical treatment is not required.

Reduced water usage—The condenser runs in the dry mode the majority of the time, only using water when the ambient temperature rises above a predetermined setpoint. That allows for a reduction in water use of up to 90% versus other water-based systems.

Electrically commutated fans—The low-efficiency fans typically found in air-cooled condensers have been replaced with high-efficiency, ultra-quiet EC fans with integral vari-
able-speed drives. This can reduce fan energy use by up to 75% depending on the ambient conditions (the lower the head pressure, the more capacity the compressors gain due to the lower compression ratio). Depending on those aforementioned ambient conditions, even greater energy savings could be achieved, as the cooling systems are now able to run at lower, far steadier head pressures.

**PLC controller**—The PLC controller is used to control the fan speed (to match cooling demand) and actuate the pre-cooling function.

**Lightweight/recyclable**—An all-aluminum construction makes the unit durable, lightweight, easy to support and 100% recyclable.

The system works on the adiabatic principle of heat rejection. By extracting energy from the air to provide energy to evaporate water, the resulting reduction in air temperature then can be used in turn to cool a conventional radiator-type heat exchanger (see Figure 1).

The heat exchanger would in turn contain a fluid requiring cooling. In a retrofit science, the fluid requiring cooling would be the water used to run through the pre-existing cooling tower. Where heat rejection is required for a chiller compressor, greater efficiency is achieved by running the refrigerant through the heat exchanger.

**The installation**

In the case of the Southwick Big Y supermarket, the installation of the store’s hybrid condenser took three days. The first two days were spent on preparation work, which included placing the unit on structural steel, running the refrigerant piping from the existing condenser to the inlet of the new unit, running a water line new unit, and bringing over the power and control wiring. The actual changeover took place on day three. To implement the changeover, the refrigeration system was shut down for approximately two hours.

During the peak heat of the day with the roof temperature at approximately 89°F, Big Y Senior Technical Specialist Ken Soto witnessed the conditions listed in Table 1 using Big Y’s facility-management system and made the following observations:

1. The 185-lb head pressure measured at rack A is within 2°F of ambient, while racks B and C could do no better than 22°F above ambient. The compressor manufacturer’s data suggests that this 20°F differential will reduce compressor energy use by about 20%, while substantially increasing cooling capacity.

2. The previous day, under similar ambient conditions but with the old air-cooled condenser still running, the head pressure on rack A had been roughly 250 lb and all five 7.5-hp compressors were running to satisfy the load. With the new hybrid unit in place, at least two compressors were cycled off and the case temperatures were being easily maintained.

3. Additional energy savings was achieved via the hybrid condenser, as two high-efficiency EC fans were running instead of the four standard-efficiency fans on the air-cooled condenser. Since the EC fans have integral VFDs, their speed is reduced as the ambient temperature falls, realizing additional savings.

<table>
<thead>
<tr>
<th>Rack</th>
<th>Temp</th>
<th>Condenser</th>
<th>Head Pressure (psi)</th>
<th>Condensing Temp (°F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Low</td>
<td>Hybrid</td>
<td>185</td>
<td>85</td>
</tr>
<tr>
<td>B</td>
<td>Medium</td>
<td>Standard air-cooled</td>
<td>256</td>
<td>105</td>
</tr>
<tr>
<td>C</td>
<td>Medium</td>
<td>Standard air-cooled</td>
<td>253</td>
<td>104</td>
</tr>
</tbody>
</table>
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4. With the hybrid unit in place, the rack A receiver had roughly 50% more refrigerant than with the old condenser. That is because the hybrid unit’s heat exchangers require far less refrigerant than the old condenser coils.

Western Massachusetts Electric Co.—which provides electricity to the Big Y supermarket—evaluated the installation for the purpose of granting an energy-conservation incentive. Since the hybrid unit passed, the supermarket has seen 50% of the capital equipment cost returned in the form of a rebate as a result of this technology.

The future

“While in recent years there have been significant efficiency advancements in devices like lighting, motors, fans, and individual components within refrigeration and air-conditioning systems, air-cooled condensers have remained relatively unchanged,” said Muller North America Vice President of Sales and Marketing Paul Noreen. “The hybrid condenser changes all of that. It is exactly what is needed as we face the unprecedented environmental challenges ahead.”

While the cost savings and payback periods generated as a result of integrating hybrid-condenser technology are highly dependent on heat-rejection loads, as well as operational and typical ambient conditions, significant cost savings are available in comparison to most air-cooled systems over 25 kW and water-cooled systems under 3 MW. Other regional factors, such as the local cost of electricity, also will impact how much energy savings can result from an installation.

However, as more standards and requirements are placed on HVACR systems, and an ever-increasing need for power pushes the cost of energy higher, opportunities to integrate hybrid condensers into the supermarket sector (and beyond) will continue to grow.

Marc Sandofsky has a B.S. in mechanical engineering and a B.A. in economics from Tufts University, an MBA in marketing from Babson College, and has been awarded numerous U.S. patents on cooling-related energy conservation processes. For more information, visit www.mullerna.com.