Proper Condensing Unit, Unit Cooler and Components Selection

A step-by-step guide to help with the proper selection of refrigeration equipment for a walk-in cooler or freezer.

BY ANDY SCHOEN, CM
Images courtesy of Sanhua International.

When given the task of specifying the refrigeration equipment for a walk-in cooler or freezer, one must make an educated assessment of its heat load so that the equipment can be sized appropriately. Estimating this heat load is not difficult to comprehend.

Heat-load calculations are typically categorized into the following:

→ Transmission load—The heat gain through the walls, floor and ceiling in the walk-in. It also includes any solar gain if the walls or ceiling are located outdoors;
→ Infiltration load—The heat gain when access or service doors are opened and closed. Infiltration load is normally assumed in most walk-in box heat load calculations to be zero when the doors are closed. In other words, the walk-in does not have a problem with door seals or its vapor barrier;
→ Product load—The heat gain resulting from bringing the product being stored down to room temperature; and
→ Miscellaneous loads—All other unaccounted heat loads. They would include lighting, fan motors, lift trucks, process machinery and people.

Doing a heat-load estimation is not as difficult as it first might appear. Take advantage of the available heat-load calculation software, as it tends to be a great help. All major condensing unit manufacturers generally make this software available. Contact their technical services department and ask about availability.

If heat-load estimation is something you prefer having someone else handle, most refrigeration wholesalers have one or more individuals trained in this task. At a minimum, you will need to provide the walk-in box dimensions, the design operating temperature and the number of service doors, if any. You will also need to specify if the condensing unit is to be located indoors or outdoors. If this is the only information you can provide, the person making the heat-load estimation will invariably use a
“quick load” chart provided by the condensing unit manufacturer. These charts make various assumptions, and generally prevent one from undersizing the equipment. The more information you can supply regarding the application, however, the closer the equipment can be sized to the true heat load. This information would include:

→ Insulation type and thickness to be used in the walls, floor and ceiling;

→ Percentage of time the access door will be open during a typical day;

→ Whether or not a barrier will be employed (such as a plastic strip curtain) at the entrance of the access door;

→ The type and amount of product entering the walk-in during a typical day; and

→ Desired equipment runtime at the design load (18–20 hours/day typical).

Pay particular attention to the infiltration load. For a typical 8 x 8 x 8-ft walk-in, having the door open an average 24 minutes a day can contribute to 30% of the total heat load for coolers and 40% for freezers. Double the door-open time to 48 minutes a day, and infiltration load can contribute 45% and 60% of the total heat load, respectively. Barriers such as plastic strip curtains should be considered for applications where the access door stays open for long periods of time.

**Unit cooler**

Once the condensing unit with the proper capacity has been selected, the next challenge is to size a matching unit cooler. To do this, one needs to understand the principle of temperature difference (TD). Air-cooling evaporators are sized on the basis of TD (i.e., entering air temperature minus the evaporator temperature).
In Figure 1, air is entering the evaporator at 35°F and the evaporator temperature is 25°F, giving a 35°F – 25°F = 10°F TD. Do not confuse TD with the temperature drop of the air across the coil, typically known as “Delta T.” In the above example: 35°F – 30°F = 5°F Delta T.

Evaporator capacity varies proportionally to TD. For example, if the TD were to double, the coil capacity would approximately double. Table 1 shows a rating table for a 12,000-Btuh commercial-temperature coil rated at 10°F TD.

<table>
<thead>
<tr>
<th>TD (°F)</th>
<th>Evaporator Rating (Btuh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>12,000</td>
</tr>
<tr>
<td>15</td>
<td>18,000</td>
</tr>
<tr>
<td>20</td>
<td>24,000</td>
</tr>
</tbody>
</table>

Table 1

Selecting a proper unit cooler for a condensing unit involves, in part, making sure the unit cooler operates at an appropriate TD. From the above table, it would seem both logical and cost effective to size a unit cooler at the highest possible TD since greater TD provides greater capacity. However, selecting the proper unit cooler is not only a matter of maintaining proper temperature, but also proper relative humidity (RH). The greater the TD the evaporator operates, the more moisture is removed from the air, resulting in lower RH. Having a low RH in a walk-in is not a good solution for many applications, such as walk-ins used for cooling fruits, vegetables and packaged meat. Normally, desired evaporator TDs and their approximate RH by application and product are listed in Table 2:

<table>
<thead>
<tr>
<th>Application/Products</th>
<th>Acceptable TDs (°F)</th>
<th>Approx RH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low temperature; produce</td>
<td>8–10</td>
<td>90</td>
</tr>
<tr>
<td>and floral coolers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Packaged meat and produce</td>
<td>10–12</td>
<td>80–85</td>
</tr>
<tr>
<td>produce cooler</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beverage, short term</td>
<td>12–16</td>
<td>65–80</td>
</tr>
<tr>
<td>packaged products</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Meat prep room</td>
<td>17–22</td>
<td>50–65</td>
</tr>
</tbody>
</table>

Table 2

Additional considerations

Another consideration when selecting a unit cooler is providing proper air-flow distribution in the walk-in. This is particularly true with large walk-ins. Whenever possible, unit coolers should be selected to provide even air-flow distribution within the walk-in. Large walk-ins will often require multiple unit coolers to provide the desired result. Unit cooler data sheets specify “air throw,” which is the effective distance from the unit cooler the air-flow travels, and this data will assist in the proper placement of the unit cooler.

Note: Evaporators that are applied at elevations high above sea level will be subject to a capacity de-rating, due to the reduced air density. For example, an evaporator applied at a 5,000-ft elevation will see a 15% capacity de-rating.

Infiltration load may be reduced by locating the unit cooler opposite the access door opening. Having the unit cooler mounted directly over an access door opening can result in air being drawn into the walk-in when the door is opened.

Other problems that can result in less-than-ideal air flow are rough ceiling surfaces, low ceilings, long and narrow walk-in box dimensions, and obstructions such as beams, piping, return air restrictions, and poor product placement. The use of air straighteners should be considered when air flow is significantly affected by one or more of these issues.

TEV/liquid-line components

Once the unit cooler selection has been made, the next step is the selection of the thermostatic expansion valve (TEV) and liquid-line components. In the case of a condensing unit matched to a single unit cooler, you may ask, “do I size the TEV and liquid-line components to the evaporator capacity or the capacity of the condensing unit?” As Dr. Seuss once opined, “Sometimes the questions are complicated and the answers are simple.” Perhaps in this case, we have a simple question, and a complicated explanation.

One needs to size the TEV and liquid-line components to the evaporator capacity they are connected to. But then one needs to know the TD at which the evaporator is operating at to know the evaporator capacity. And to know the TD at which the evaporator operates, one needs to know the capacity of the condensing unit.

The formula for calculating the TD at which the evaporator operates at:

\[ \text{Evaporator TD} = \frac{\text{condensing unit capacity} \times \text{evaporator rating}}{\text{evaporator rating}} \]
Figure 2 illustrates the normal piping sequence for the TEV and liquid-line components.

In an effort to simplify things, some unit cooler manufacturers supply “built-up” units that include the TEV, a liquid-line solenoid valve and a thermostat. If the unit cooler comes supplied in this manner, you will want to know at what TD the TEV and solenoid valve were sized. For example, consider the 12,000-Btuh evaporator coil example once again rated at a 10°F TD. If we applied it to an 18,000 Btuh condensing unit, and using the above formula, the coil would operate at a $18,000 \times 10 \div 12,000 = 15°F$ TD. If this coil is supplied with a TEV and solenoid valve sized at 10°F TD, we could expect them to be undersized at these conditions.

A condensing unit matched to multiple unit coolers requires one to understand the TD at which the unit coolers operate. There is no shortcut to TEV and solenoid-valve sizing by simply knowing condensing unit capacity.

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