

8.3.3 Condensers

§126(d)

The most common refrigerants in use today are either single component or azeotrope refrigerants. An azeotrope is a blend of different components that together form a mixture with its own unique set of thermodynamic properties. A good example of an azeotrope would be a mixture of salt and water; both single component and azeotrope refrigerants boil and condense at the same temperature for a given pressure.

Other refrigerant types called zeotropes are blends of several components that do not combine and form a mixture. In this case the individual components retain their own thermodynamic properties. A good example of a zeotrope is a blend of oil and water. For zeotropic refrigerants at a given pressure, the saturated vapor temperature (dew point) is not the same as the saturated liquid temperature (bubble point). The difference in these two temperatures is called *temperature glide*. PT chart information published by manufacturers for blends with temperature glide greater than about 5 degrees F generally list both the bubble-point and the dew point pressure at a given temperature.

Saturated Condensing Temperature (SCT). For single component and azeotrope refrigerants, SCT is the saturation temperature corresponding to the refrigerant pressure at the condenser entrance. For zeotropic refrigerants, the SCT is the arithmetic average of the dew point and bubble point temperatures corresponding to the refrigerant pressure at the condenser entrance.

All refrigeration systems using ammonia as the refrigerant must be evaporatively cooled. This requirement may be met by an evaporative condenser or by use of a water-cooled condenser connected to a closed loop fluid cooler or cooling tower. Air cooled condensers and groundwater condensers are not permitted in ammonia systems. The condensers (whether evaporative condensers or water-cooled condenser plus cooling tower/fluid cooler) must be sized to provide sufficient heat rejection capacity under design conditions while maintaining a specified maximum “approach” temperature that varies by climate. When determining design heat rejection rates, reserve or backup compressors are not included in the total heat rejection calculations. The approach temperature is defined as the difference between the saturated condensing temperature and the outdoor wet-bulb temperature. Designers should use the 0.5 percent design wet-bulb temperature from Table 2-3 – Design Day Data for California Cities in the Reference Joint Appendices JA2 to demonstrate compliance with this requirement. The approach temperature requirements are listed in Table 8-2.

Table 8-2 Condenser fans for evaporative condensers must be continuously variable speed. Variable frequency drives are commonly used to provide continuously variable speed control of condenser fans. The condensing temperature control system must be designed to control all fans serving a common condenser loop in unison. Thus, the fan speed of all fans within a single condenser or set of condensers serving a common high side or cooling water loop should modulate together, rather than running some fans at full flow while controlling the condensing temperature by varying the speed of a single fan. Once the fan speed has been reduced to a minimum level, fans may be shut down while modulating the speed of the remaining fans to maintain the condensing temperature set point.

The minimum saturated condensing temperature set point for systems utilizing evaporative condensers must be 70°F (21°C) or less. To provide stable system operation at the minimum condensing temperature, all components in the system must be capable of operating at a saturated condensing temperature less than or equal to the minimum saturated condensing temperature set point.

To minimize overall system energy consumption, the condensing temperature set point in evaporatively cooled systems must be reset using outdoor wet bulb temperature (i.e. variable set point control) rather than controlling to a single set point.

Alternative set point control strategies may be utilized which achieve similar results to the prescribed wet bulb following control method; controlling fan speed by utilizing calculations or mapped performance to minimizing total compressor and condenser fan power. These controls are uncommon but may be used if the control method is sufficiently described and proven to the satisfaction of the local enforcement agency.

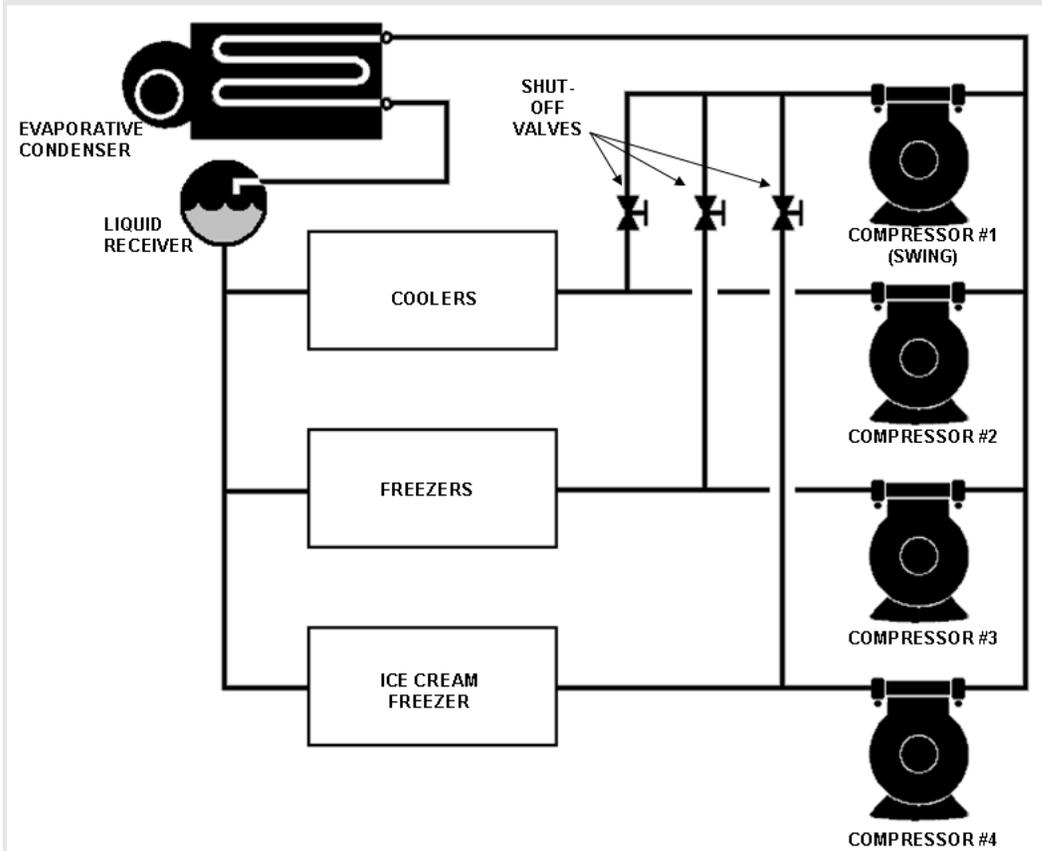
Table 8-2 – Approach Temperature Requirements for Evaporative Condensers

0.5% Design wet-bulb temperature from Table 2-3	Maximum Approach Temperature
$\leq 76^{\circ}\text{F}$ (24°C)	20°F (11°C)
Between 76°F (24°C) and 78°F (26°C)	19°F (10.5°C)
$\geq 78^{\circ}\text{F}$ (26°C)	18°F (10°C)

Example 8-9

Question

The refrigerated warehouse compressor plant shown below has a backup or “swing” compressor. Does the heat rejection from this compressor need to be included in the condenser sizing calculations?

**Answer**

No. The heat rejection calculations for purposes of this Standards exclude compressor(s) that are used solely for backup. In this case, the calculations would include the heat of rejection from Compressors 2, 3, and 4 and would exclude Compressor 1.

Example 8-10

Question

A system is to be designed with an evaporative condenser in a location where the 0.5 percent design wet bulb temperature is 72°F (22°C). What is the maximum design approach?