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Uncover the Hidden Assets in Your Condenser Water System

50 percent more cooling capacity from cooling towers

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Did you realize that in many applications your existing cooling tower, condenser water pipes, and condenser water pump can deliver at least 50 percent more cooling capacity? More often than not, when we use the following scenario with building designers and building owners to discuss a method to increase cooling capacity, they turn to each other and say, "That's our building!" This method certainly isn't new, but its application may help you uncover the hidden assets in your building's condenser water system.

	Present Building	To double capacity	To satisfy 50 percent additional load
Desired capacity	500 tons (1,760 kw)	1,000 tons (3,250 kw)	750 tons (2,640 kw)
Cooling tower conditions			
Ambient wet bulb	78 F (25.6 C)	78 F (25.6 C)	78 F (25.6 C)
Flow rate	1,500 gpm (95 lps)	1,500 gpm (95 lps)	1,500 gpm (95 lps)
Entering water temperature	95 F (35.0 C)	110 F (43.3 C)	103 F (39.4 C)
Leaving water temperature	85 F (29.4 C)	90 F (32.2 C)	88 F (31.1 C)

TABLE 1. Building characteristics, chiller capacity, and cooling tower conditions. The addition to the present building includes 250 tons capacity, and is already over budget.

A FAMILIAR SITUATION

- The building in question (See Table 1) has a 500-ton (1,760 KW cooling capacity) chiller that is 25 years old. The chiller has been less dependable the past few years and should be replaced.
- The fill in the 500-ton (1,760 KW) cooling tower was replaced two years ago and the tower is in good shape.
- The condenser water piping and pump are in good shape, although the flow is near the maximum rate recommended for the piping. As is often the case, the cooling tower is remote and the condenser water piping is buried beneath a road.
- The addition to the building (or the change in the building's use) significantly increases the cooling load—in this case by 250 tons (880 KW cooling capacity).
- The building owner met briefly with a friend who told her that the chiller, cooling tower, condenser water pump, and condenser water pipe must be changed.
- Not surprisingly, the project is over budget.

The largest piece of misinformation in this scenario is that the cooling tower has a capacity of 500 tons (1,760 KW). Examining and disproving this assumption provides an alternative that costs much less.

HOW MUCH CAPACITY DOES THE COOLING TOWER REALLY HAVE?

The following example assumes replacement of an electric chiller with another electric chiller. Chillers using a different fuel source, such as steam (turbine drive or absorption chiller) or natural gas, require more heat to be rejected. It is also true that with today's efficient electric chillers, less heat than 15,000 Btuh is rejected per ton of cooling load. The bottom line is that the design engineer should consider all the options and see if the building's infrastructure can be used by selecting an appropriate new chiller.

The cooling tower was probably selected for these design conditions:

- Ambient wet-bulb temp = 78 F (25.6 C)
- Flow rate = 1,500 gpm (95 lps)
- Entering water temp = 95 F (35 C)
- Leaving water temp = 85 F (29.4 C)

$$\text{Heat-rejection capacity} = \frac{500 \times \text{gpm} \times \Delta T}{(15{,}000 \text{ Btuh per cooling ton})}$$

$$= \frac{500 \times 1{,}500 \times 10}{15{,}000}$$

$$= 500 \text{ cooling tons}$$

At this point many people assume that the heat rejection capacity of the cooling tower is

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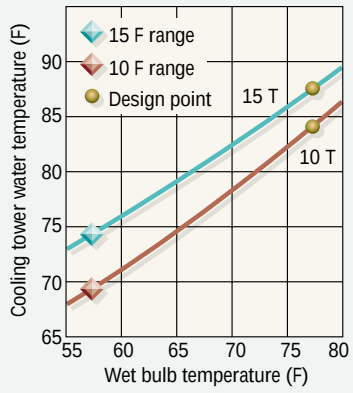

FIGURE 1. Cooling tower selection at different ranges.

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fixed at 500 tons. A closer examination of this equation makes it obvious that its true capacity (at a given ambient wet bulb) depends on the flow rate and temperature difference. If we want to use the existing pump, piping, and cooling tower, the flow rate is a constant; however, we can still change the available capacity by changing the temperature difference.

INCREASE CAPACITY BY INCREASING THE TEMPERATURE DIFFERENCE

Expanding the temperature difference to 20 F (11.1 C), for example, effectively doubles the heat rejection capacity of the cooling tower. Using the cooling tower manufacturer's selection program, we find that the existing cooling tower operates at the following conditions:

- Entering water temp = 110 F (43.3 C).
- Leaving water temp = 90 F (32.2 C).

Therefore, from the standpoint of heat transfer, doubling the conventional 10 F (5.6 C) temperature difference permits the same cooling tower to reject twice as much heat. Of course, it is important to note that elevated temperatures can adversely affect some types of cooling tower fill. Even if that isn't an issue, some designers are simply uncomfortable selecting chillers at twice the conventional temperature difference. The more common 15 F (8.3 C) temperature difference offers similar benefits.

WHAT HAPPENS IN THIS CASE?

In the situation described earlier, the desired additional capacity is 50 percent. Using the cooling tower selection program and a 15 F (8.3 C) range gives:

- Entering water temp = 103 F (39.4 C).
- Leaving water temp = 88 F (31.1 C).

Figure 1 depicts the reasonableness of these cooling-tower selection conditions. Selecting a chiller at the new conditions is also reasonable, especially when balanced against the cost of replacing a cooling tower, condenser water piping, and a condenser pump. Note, too, that selecting a chiller with nearly the same condenser pressure drop as the existing chiller will not affect the existing flow rate. Table 1 summarizes the selection conditions for the present building, for doubling the present capacity, and for the planned addition to the building. The designer need only select the chiller at the new conditions to achieve the desired cooling capacity.

A CAVEAT

Care should be taken when there are multiple chillers, a common cooling tower, and only one chiller is being replaced. The resulting cooling tower temperature should be calculated and the existing chillers should be checked to ensure they operate properly at this elevated temperature.

SUMMARY

Building owners and designers often struggle with meeting additional cooling capacity requirements when additions or modifications take place. Understanding that cooling tower capacity is not fixed permits the judicious use of existing infrastructure (piping, pump, and tower). Selecting a chiller based on the proper conditions lets building owners tap the hidden assets in their condenser water systems and provides designers with a powerful retrofit tool for applications that require additional cooling capacity.

REFERENCE

Burger, R., September 1993. "Wet Bulb Temperature: The Misunderstood Element," *Heating/Piping/Air Conditioning*.

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