Cooling Towers: How to Make the Correct and Best Selection?

By Georges Hoetierickx
Director Business Development Evapco Europe

Cooling towers are becoming more and more popular and the standard heat rejection method in today`s cooling systems because of their high efficiency allowing to design cost effective systems with maximum system efficiencies. The aim of this article is to make an overview of some important criteria when selecting or specifying a cooling tower for your project. In this article we will limit ourselves to packaged type of cooling towers and not field erected cooling towers. Packaged type cooling towers generally go from 100 up to 1200 tons capacity per single cell.

1. Design Criteria of a Cooling Tower: Approach.

The size of a cooling tower depends on the flow, water inlet and outlet temperatures and the design wet bulb temperature. The difference between the water outlet and wet bulb temperature is called the approach. The smaller the approach, the larger the size of the tower. Economical selections are based on selections using an approach of 4 °C. Selections using an approach smaller than 2,8 °C are not economical, nor will be certified by CTI. Selections using approaches more than 4 °C result in higher condensing temperatures (reduced chiller efficiency and performance) without much savings on the cooling tower.

2. Performance : CTI Certification

While it is not easy for an expert to compare different cooling towers with regard to performance and confirm which one is correctly sized, this task will be even more challenging for non experts.

Therefore it is strongly recommended to limit the choice of the cooling towers to those who are CTI certified. CTI (Cooling Technology Institute) is an independent organization which is well recognized around the world and most global cooling tower manufacturers have their cooling tower ratings verified and confirmed by CTI as part of the CTI Certification program. Selecting such cooling tower assures you will receive the specified performance and also assures a fair game between all the different equipment manufactures.

Products which are undersized are still a common practice and the final owner / user pays the penalty for the undersized cooling tower by having his system running at higher condensing temperatures and as such lower efficiencies. Some manufactures have certified products but don't hesitate to offer non certified products too.

It is easy to go to the CTI website (www.cti.org/cooling tower certification) to find the list of all cooling tower manufacturers and their respective certified products and models and make sure your receiving what you expect. In case of doubt one can always contact CTI.

3. International Building Code (IBC)

The International Building Code (IBC) is a comprehensive set of regulations addressing both the structural design and the installation requirements for building systems, including HVAC equipment. Compared to previous building codes that considered only the building structure and component anchorage, the requirements contained within the IBC address anchorage, structural integrity and operational capability of a component following either a seismic or wind load event. Simply stated, the IBC code provisions require that the cooling towers and all other equipment permanently installed on a structure must be designed to meet the same seismic and wind load forces as the building they are attached.

Cooling towers should be independently certified by an independent approval agency to confirm they meet specified design conditions such as wind load and seismic forces.

A common value for the wind forces used in the region is 2,8 kN/sqm or 110 km per hour wind velocity.

4. Axial or Centrifugal Fan Type Cooling Tower

Both types of cooling towers are available: one type, forced draft, using centrifugal fans and the other type, induced draft, using axial fans.

The major advantages of the axial type fans are:

- Much lower energy consumption, normally in the range of 50 % less.
- Easier maintenance
- Lower cost per ton of heat rejection

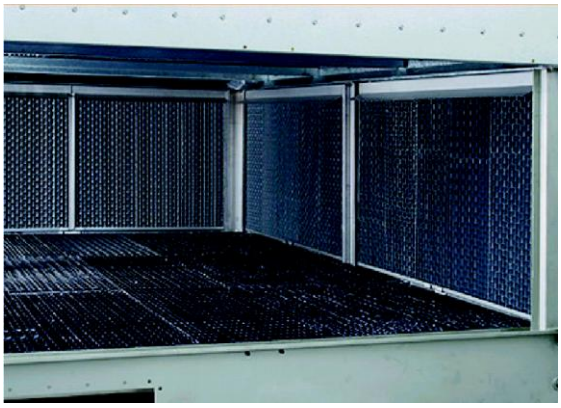
Therefore, induced draft axial fan type cooling towers should always be the first choice.

The only reasons why centrifugal fan type units can or should be considered are applications where the cooling towers are installed inside the building and the fans must handle an extra static pressure or when extreme low sound levels must be achieved.

It is important to know that thanks to modern fan technology developments also axial fan units can be made available meeting very stringent sound criteria without being penalized on the power consumption of the centrifugal fan units.

The picture below shows a typical super low sound fan. These fans reduce the cooling tower noise levels with 9 to 15 dB(A). Further noise reductions can be achieved by installing water silencers (see picture) to eliminate the noise of the falling water.

Super low sound fan



Water silencers

5. Cooling Tower Efficiency (kW Fan versus Ton Heat Rejection)

When designing or selecting a cooling tower one can minimize the first cost of the cooling tower and end up with a tower having high power consumption. In Kuwait for example, the Ministry of Electricity and Water issued two years ago a Code of Practice to be followed in order to rationalize the power consumption in buildings.

For cooling towers they specify the maximum power rating of the fan motors should not exceed 0,04 kW per ton heat rejection. With today's designs available this target is relatively easy to achieve even with CTI certified products. However, there are still manufactures offering lower cost axial fan models resulting in power consumptions which require 30 % more fan power then the more efficient solution. Over a period of ten years this represents a significant amount of kWH and electricity cost.

6. Type of Cooling Tower Configuration : Crossflow Versus Counterflow Type ?

The old style crossflow type cooling towers are getting more and more replaced by the more efficient, user friendly counterflow type cooling towers. This type is already the standard at all Middle East district cooling plants and now becoming more and more used as a packaged tower.

Major reasons to specify, demand or select a counterflow type cooling tower are:

- Single water inlet per cell: easier piping and no balancing per inlet needed. This is a major issue with crossflow type of towers were the condenser water is fed to two open hot water basins at the top, which need to be balanced with expensive valves to ensure proper distribution over both sides of the cooling tower.
- Easy access to the sloped basin for maintenance and operation makes this type the favorite of the users.
- The fill is completely encased in the unit casing and as such has a maximum of protection.
- No direct sunlight can come in contact with the water in circulation in the tower: this is an important feature which reduces the potential for algae growth and development in the cooling tower and thus reducing water treatment and maintenance costs. In crossflow type of cooling towers sunlight is in direct contact with the water at the air inlet sides and in the basin through the fan opening on the top.
- Sand and dust are in the plenum beneath the fill washed out of the water before the air enters the fill; in a crossflow type the air contaminated with sand and dust enters directly the fill at the air entry sides causing fast contamination and scale built up in the fill.

7. How to Operate Your Cooling Tower Safe and Efficient?

The above is the title of a guideline published by Eurovent a few years ago and describes the required measurements to be taken to assure your cooling tower will operate safe and efficient, but more focused on the prevention of the development and spread of Legionella (LD) Bacteria.

Some of the major requirements for a cooling tower to minimize or avoid the development of LD bacteria in the cooling tower are as follows:

- The basins must be designed for minimum water content and have (a) sloping bottom panel(s).
- No direct sunlight in contact with the water in the cooling tower.
- No dead zones where debris can accumulate and difficult to remove.
- Spray system: non corrosive and easy to clean.
- Minimum drift losses.

When considering these important criteria it is almost obvious that the old style crossflow tower no longer meets any of these requirements and more and more high level designs move towards counterflow type of cooling towers (see also 6).

Crossflow towers have the sunlight directly shining into the basin. The result is shown in the picture below.

Algae formation in crossflow cooling tower basin

The direct sunlight combined with the warm cooling tower water results in a strong formation of algae in the basin, increasing maintenance and water treatment costs.

The area beneath the fill in a crossflow cooling tower is nearly impossible to inspect or access. Dirt will easily accumulate, also because the low water velocities in this area, which will enhance the possibility for LD contamination of the cooling tower water.

Drift losses in crossflow towers are five times higher compared to counterflow where Eurovent certified values of 0,001 % easily can be achieved. Besides the higher water losses with crossflow type of towers, the potential spread of contaminated droplets from a crossflow tower is five times higher as with the modern counterflow cooling towers.

8. Materials of Construction

Cooling towers can be made of different kinds of materials such are galvanized steel, stainless steel or Fiberglass Reinforced Plastics (FRP) or a combination of these.

Considering the harsh conditions cooling towers operate in Qatar, galvanized steel even protected with any type of coating can be questioned, especially for the water basin components. Stainless steel offers an excellent alternative and clients have the choice between SST 304 L or 316 L type. The last one is more expensive but offers better corrosion resistance in high chloride environments.

The use of FRP should be handled with much more caution for several good reasons:

- There are many FRP quality gradients in the market and the cheaper are certainly not the better ones; Special attention must be paid to the flammability rate of these material, U.V. protection and resistance.
  High quality FRP is not cheap, but offers excellent characteristics with regard to corrosion and structural strength.
- Some manufactures build only a steel frame, often from galvanized steel and use low cost light weight FRP panels as casing panels of the cooling towers. These structures are certainly not corrosion resistant, the panels don't stop sunlight to enter the fill section, have a high flammability and no structural strength.
  Often these towers are wrongly called "FRP" type of towers, which is a complete wrong perception.

9. Origin of Manufacturing

Know where the cooling tower will be made and will it be in the manufacturer's own premises or outsourced to foreign subcontractors. In the last situation, there is most likely assurance needed about the final quality and how you will supported in the future when you require replacement parts.

Often cooling towers are shipped unassembled to jobsites and then assembled by local labour forces. Never expect a similar quality as you would expect from a cooling tower assembled in the manufacturers own plant by his own skilled workers in factory conditions.

This practice is certainly used by suppliers outsourcing the complete manufacturing of the cooling towers.

The savings made in shipping cost don't offset the expenses and problems clients normally experience later with the units assembled on the jobsite by unskilled people in difficult conditions.

10. Summary – Conclusion

The selection of the right cooling tower for your application can be summarized as follows:

1. Use an economical approach (difference between water outlet temperature and design wet bulb) of 4 C.
2. Only select CTI certified models: you are sure you will receive a correct performing unit.
3. Make sure the tower structural design meets the right standards to withstand local conditions and the product is IBC compliant.
4. Whenever possible select axial fan units. Consider super low sound fans when low noise levels are needed.
5. Select or specify efficient cooling towers: 0,04 kW/ ton
6. Prefer counterflow type of cooling for the many obvious reasons mentioned before.
7. In order to have a tower which will offer you the minimum challenges to control LD development in your cooling tower, go for counter flow types.
8. Either go for a full stainless steel type cooling tower or a full FRP. Don't get misled by poor quality FRP materials and concepts.
9. Prefer factory assembled units and make sure you know where they are built. Visit the plant and inspect the towers while being assembled.