Cooling Tower Performance

APPROACH

The simplest function of a cooling tower is to cool water to a desired temperature. In the cooling tower industry, this desired temperature is referred to as the *cold water temperature* due to the fact that it is cooler than water entering the tower. For evaporative processes, the difference between the cold water temperature and entering wet bulb temperatures is the ***approach***. However, there is a lot more to understand about approach than simply the difference between two temperatures. The following information will highlight what approach is, how it relates to ***range***, and how it is affected by variables such as heat load, tower size, and airflow.

Cooling tower manufacturers often use approach as a benchmark for cooling tower performance. All other things being equal, a cooling tower with a smaller approach is thermally superior to a tower with a larger approach. Due to the influence approach has on cooling tower performance, some select or modify towers to reach the lowest approach that is economically feasible. These economics are largely dependent on the project and purchaser.

A common misconception is that *range* — the difference between hot water temperature and cold water temperature — is influenced by cooling tower performance. In reality, approach is what actually defines the cooling capability of a cooling tower. The range is influenced by the heat rejection of the process for which a cooling tower serves. Whether a power plant, commercial building, or any other application, the range will stay consistent under the same flow and heat rejection conditions. **Figure 1** shows the relationship between approach and range. To learn more about range, download the *Cooling Tower Range Thermal Science Paper TR-017 at spxcooling.com*.

To fully grasp the concepts surrounding approach, some background of other common cooling tower conditions is necessary. The main cooling tower variables that dictate approach are heat load, tower size, and airflow. In the case of natural draft cooling towers, air density differences play a role in determining the air flow.

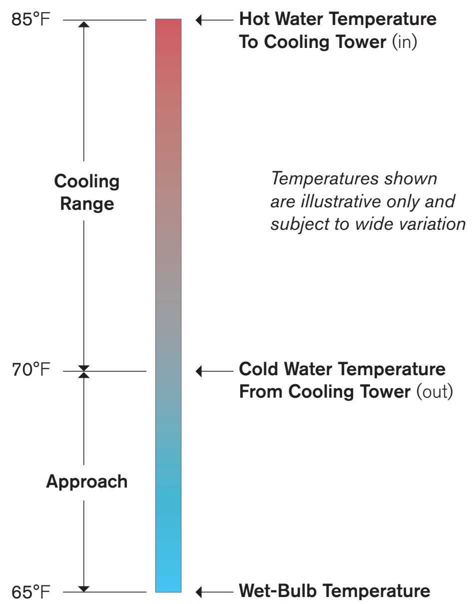

Figure 1 Relationship between range and approach in cooling tower operation

The approach of a cooling tower varies ***directly*** with the heat load of a process. Heat load is defined as the total heat to be removed from the circulating water by the cooling tower per unit time (Btu/hr). Heat load is a function of water flow rate and range. Because of this, heat load will increase with increasing flow and/or range. A cooling tower that is cooling less of a heat load can cool to lower cold water temperatures than a similar cooling tower cooling more heat load.

Cooling tower size also plays a major role in approach. Unlike flow, cooling tower size varies inversely with approach as shown in **Figure 2**. A shorter approach requires a larger cooling tower. Typically, below a 5°F approach, the effect on cooling tower size begins to become asymptotic. For this reason, it is not customary in the cooling tower industry to guarantee any approach of less than 5°F. This is not because cooling towers are unable to produce a 5°F approach but because any errors in measurement become very significant when performance is calculated or tested.

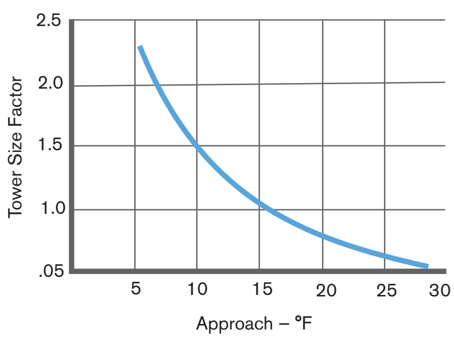

Figure 2 Cooling tower *size* versus approach

The last major variable that has an effect on approach is airflow. Approach varies *inversely* with airflow. Mechanical draft cooling towers have relatively constant airflow that is induced by a fan or centrifugal blower. Conversely, natural draft cooling towers rely on buoyancy to drive airflow similar to a chimney. This buoyancy force is derived from air density differences inside to outside of the cooling tower shell. Therefore, air density has a stronger impact on natural draft cooling towers than mechanical draft cooling towers with regards to airflow.

Summary

- Approach is the difference between the cold water and the wet bulb temperatures.
- Approach varies inversely to cooling tower performance and is used as the benchmark for measuring the cooling capability of cooling towers.
- Approach is influenced by cooling tower performance characteristics. Range is influenced by the process water source.
- The main cooling tower variables that affect approach are heat load, tower size and airflow. Airflow is influenced by air density differences in the case of natural draft cooling towers.
- The approach of a cooling tower varies directly with the heat load of the process.
- The approach of a cooling tower varies *inversely* with the size of the cooling tower.

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