Analysis of the Section Factors of Cooling Towers and Its Influence on Cooling Tower Selection

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Abstract: Introduce the model selection elements of cooling tower, study the influence of changes in various model selection factors on the final cooling tower size. Provide guidance and suggestions for the setting of specific cooling tower working conditions.

Keywords: **cooling tower model selection factors, approach temperature, cold amplitude, cooling tower working condition setting.**

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As a general cooling equipment, cooling tower has a wide range of applications in central air conditioning systems. Different industries have different requirements for the cooling capacity of cooling towers. For example,Chinese national standard { GB/T 7190.1-2018 Mechanical Ventilation Cooling Tower, Medium and Small Cooling Tower}, the general design standard is inlet water temperature in 37℃, outlet water temperature is 32℃, wet bulb temperature is 28℃. However, in the actual engineering design process, due to different types of chillers and different manufacturing standards, the engineering requirements for cooling towers are also different. Most chiller manufacturers will match the inlet and outlet water temperature of the cooling tower according to their own design and manufacturing standards. For example, the standard condensate temperature requirement for chillers in the United States is 35/29.5/25.5°C. The standard condensate temperature requirements of Japanese chillers are mostly 35/29.5/27℃.The temperature of the condensed water of the national standard chiller is mostly 37/32/28℃. Due to the difference in working condition settings, many unscientific or wrong model selections will appear in the design and selection of cooling towers, leaving hidden dangers to project acceptance and equipment performance. Due to the different geographic environments,various designs have reasonable point, but they will seem unreasonable when applied in different places, especially in multinational projects. When designing the selection, it is necessary to modify the parameters appropriately to achieve the optimization of performance and cost.

1. Cooling Tower Selection Factors

Water flow rate (m3/h): it is one of the basic elements of cooling tower selection, refers to the circulating water flow provided by the cooling tower to the condenser of chiller.

Inlet water temperature (℃): it refers to the temperature of circulating cooling water when returning from the chiller condenser to the cooling tower inlet.

Outlet water temperature (℃): it refers to the temperature of circulating water delivered to the condenser at the outlet of cooling tower.

Wet-bulb temperature (℃): it usually refers to the design wet bulb temperature, in order to ensure that the performance of the cooling tower meets the project requirements, it will be set slightly higher than the actual wet bulb temperature at the actual project location.

Dry-bulb temperature (℃) : it refers to the air temperature at the location of the project.

altitude (m) : it refers to the height of the cooling tower installation location relative to sea level.

Atmospheric pressure (KPa): it refers to the atmospheric pressure where the project is located.

2. Influence of Various Model Selection Factors to Selection of Cooling Tower

Due to wet bulb temperature, dry bulb temperature, relative humidity, there have a mutual contrast relationship. Determine two of these factors, and the third factor will be determined accordingly. Here we mainly take the wet bulb temperature as the main research factor. Atmospheric pressure has a certain influence in the model selection of cooling tower, the project of plateau should be appropriately consider .

In most areas is not much different for altitude, It will not be studied as a key factor here. Therefore, the following makes a comparative study based on different cooling water flow rate, inlet temperature, outlet temperature and wet bulb temperature.

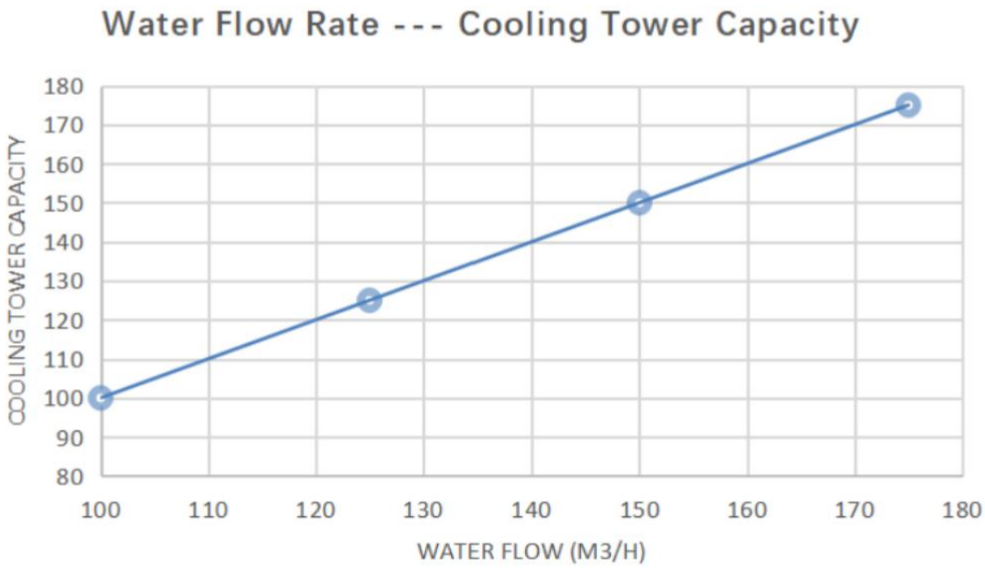
2.1 The influence of cooling water flow change on the size of cooling tower selection

Calculation of model selection was made by NEWIN cooling tower selection software.

Selection of working conditions

Water flow Rate (m3/h)	Inlet water temperature (℃)	Outlet water temperature (℃)	Design wet bulb temperature (℃)	Cooling tower capacity NST series
100	37	32	28	100
125	37	32	28	125
150	37	32	28	150
175	37	32	28	175

Corresponding Curve



Graph 1

Saw from above figure, the change in flow rate is proportional to the size of cooling tower.

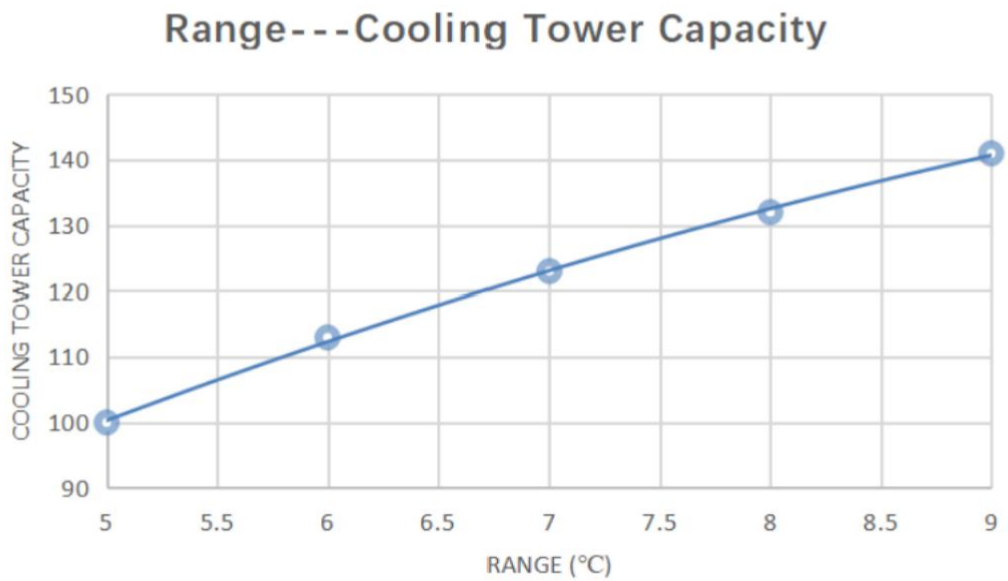
2.2 Influence of temperature difference (range) of inlet and outlet water on the size of cooling tower.

Range= Inlet water temperature - Outlet water temperature （℃）

Selection of various working conditions

Water flow Rate (m3/h)	Inlet water temperature (℃)	Outlet water temperature (℃)	Range (℃)	Design wet bulb temperature (℃)	Cooling tower capacity NST series
100	41	32	9	28	141
100	40	32	8	28	132
100	39	32	7	28	123
100	38	32	6	28	113
100	37	32	5	28	100

Corresponding Curve



Graph. 2

It can be seen from the above figure that the range increases, the cooling tower capacity increased, but it is not directly proportional. As the inlet water temperature increases, the increase value in cooling tower capacity decreases.

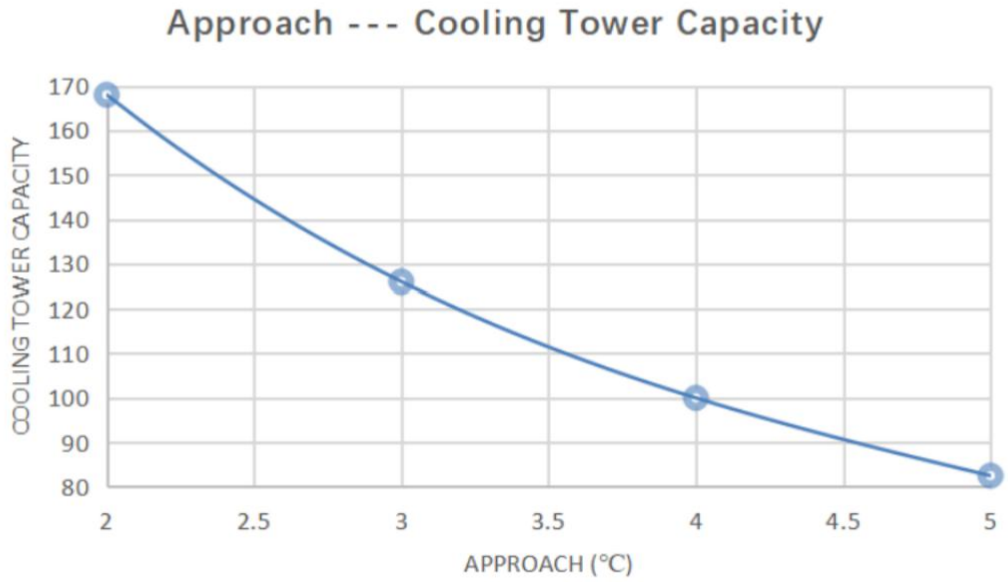
2.3 The influence of the change of the difference (approach) between the outlet water temperature and the wet bulb temperature on the size of the cooling tower

Approach = Outlet water temperature - Wet bulb temperature （℃）

Selection of various working conditions

Water flow rate (m3/h)	Inlet water temperature (℃)	Outlet water temperature (℃)	Range (℃)	Approach temperature (℃)	Design wet bulb temperature (℃)	Cooling tower capacity NST series
100	38	33	5	5	28	82.5
100	37	32	5	4	28	100
100	36	31	5	3	28	126
100	35	30	5	2	28	168

Corresponding Curve



Graph. 3

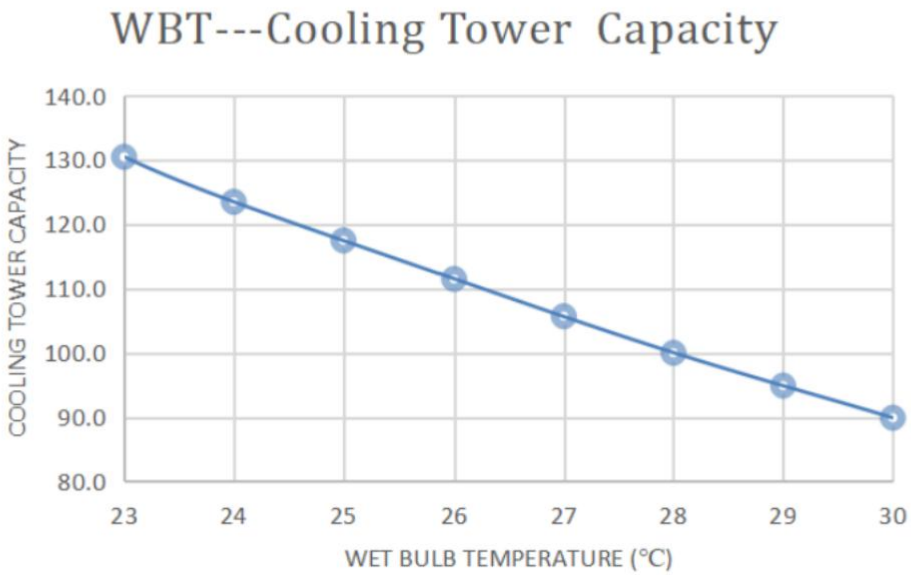
It can be seen from the figure above, the capacity of cooling tower decreases with the increase of approximation degree. It is not directly proportional, but cooling tower capacity reduction trend is slowing.

2.4 The influence of the change of wet bulb temperature on the selection size of cooling tower

Selection of various working conditions

Water flow Rate (m3/h)	Inlet water Temperature (℃)	Outlet water temperature (℃)	Range (℃)	Approach (℃)	Design wet bulb temperature (℃)	Cooling tower capacity NST series
100	39	34	5	4	30	89.9
100	38	33	5	4	29	94.9
100	37	32	5	4	28	100.0
100	36	31	5	4	27	105.7
100	35	30	5	4	26	111.5
100	34	29	5	4	25	117.5
100	33	28	5	4	24	123.5
100	32	27	5	4	23	130.5

Corresponding Curve



Graph. 4

It can be seen from the above figure that under the condition that the cold amplitude and approach temperature remain unchanged, as the wet bulb temperature increases, the cooling tower capacity selection decreases accordingly, but reduction trend is slowing.

Conclusion :

Each main selection factors of cooling tower have an impact on the choice of cooling tower capacity. Comprehensively, the water flow rate of cooling tower is directly proportional to the type selection, which can be simply calculated according to the flow rate. The changes in the temperature of inlet and outlet water and wet bulb temperature have a more complicated influence on the selection of the cooling tower, which requires complicated calculations or with the help of software to complete. It can be seen by comparing the curve graphs:

A: In the case of a constant cold amplitude, the higher outlet water temperature, the smaller cooling tower capacity and the lower cooling tower cost.
B: The designed wet bulb temperature should be determined according to actual environment. The temperature should not be set too high, which will greatly increase the capacity of the cooling tower and increase the project cost.
C: Even if the inlet and outlet water temperatures are same, the approach temperature is same, the wet bulb temperature is lower, the more difficult the cooling process, and a larger cooling tower capacity is needed to ensure cooling efficiency. Therefore, when setting cooling tower operating conditions in cold areas, the degree of approach temperature can be appropriately increased to save the cost of cooling tower.

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