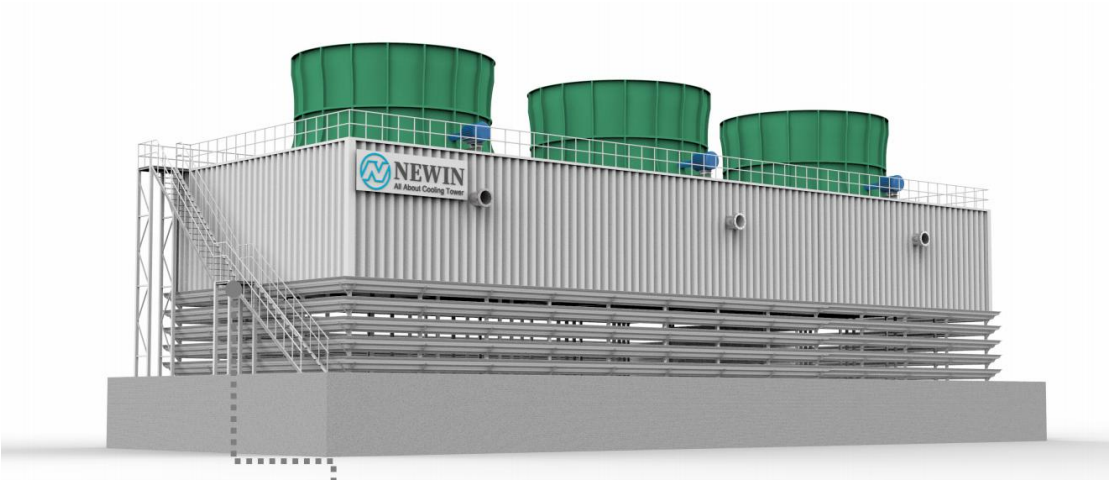
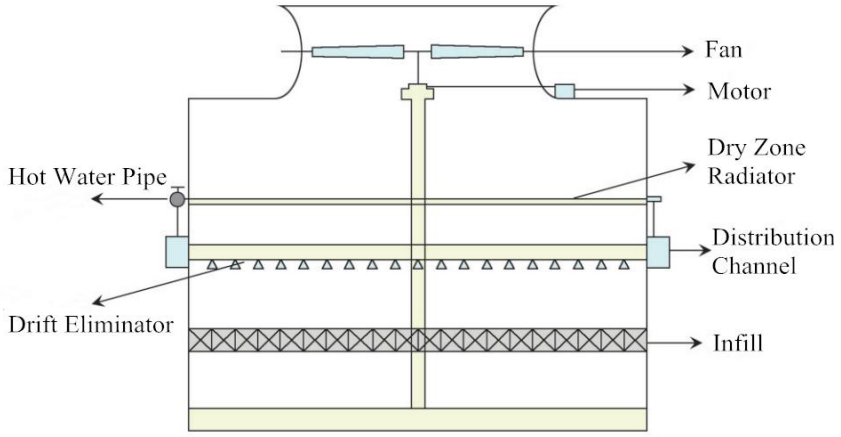
Plume Control and Water-saving Technology in Cooling Tower

The anti-plume and water-saving cooling tower is a kind of cooling tower that adopts anti-plume and water-saving measures and has the effect of anti-plume and water-saving. That is, while completing the cooling capacity of the cooling tower, it also has the effect of eliminating the plume at the outlet of the fan stack and saving water. As a kind of environment-friendly product, it has been widely used in petrochemical, electric power, metallurgy and other industrial fields and daily life. With the country vigorously advocating the economic development model of saving and environmental protection, the development prospect of demisting water-saving cooling tower is very broad. The following is a analysis of the anti-plume and water-saving technologies in the cooling tower.



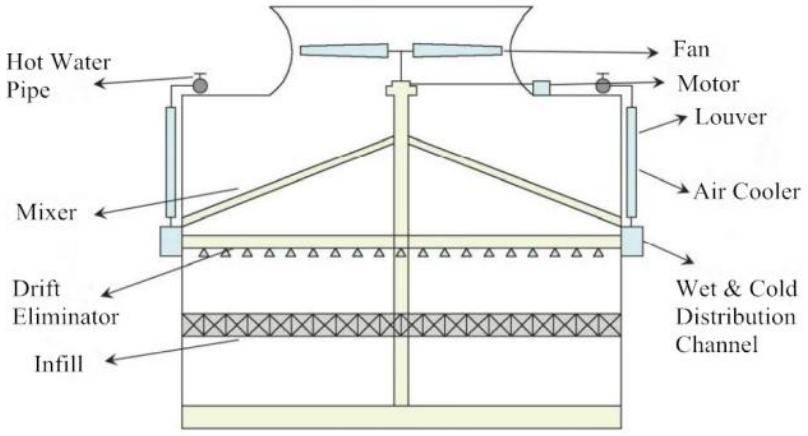
Dry Wet Mist Elimination and Water Saving Technology

This technology is relatively mature at present, divided into dry and wet series connection and dry and wet parallel connection, as shown in Figure 1 and Figure 2. The heat dissipation device in the dry zone is an air cooler, finned tube or heat dissipation tube installed in the dry zone, and the heat dissipation device in the wet zone is a water shower filler in the wet zone. Air conditioning device refers to the adjustment device of the air flow into the dry and wet zone, which can improve the efficiency of the cooling tower. In winter, reducing the air intake in the wet zone can improve the anti-plume effect of the cooling tower. The air mixing device can mix the hot air in the dry area and the hot humid air in the wet area in the tower evenly. After mixing, the temperature and humidity of the air at the outlet of the cooling tower are relatively uniform, which can ensure that the plume mass at the outlet of the tower is significantly reduced.



(Figure 1- dry and wet series connection type)

The dry and wet series connection does not need a mixer and air conditioning device, so the structure is simple. But the disadvantage is that the series dry and wet cooling towers always have dry zone air resistance during operation, and the operation cost is high. In addition, because the air flow through the dry and wet zones is the same, when the effect cannot be readjusted by air flow after the heat dissipation area is fixed. On the other hand, dry-type radiators are always in a hot and humid environment and are susceptible to corrosion,



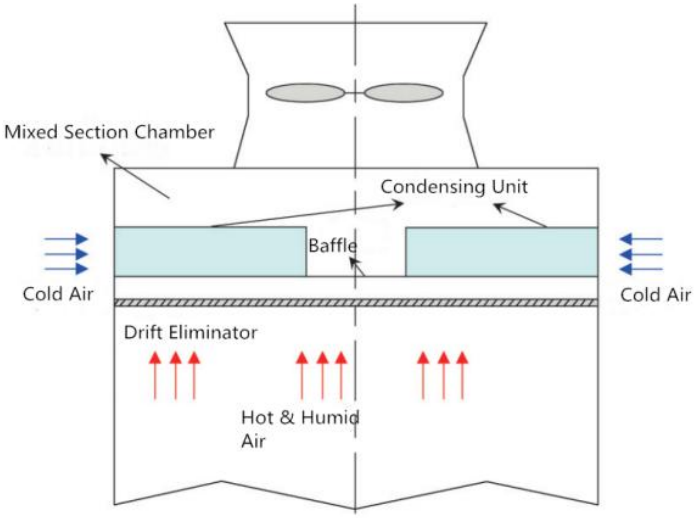
(Figure 2- dry and wet parallel connection type)

Dry wet parallel connection means that the air flow in the dry area and wet area enters the cooling tower independently of each other, and the air after heat exchange is mixed in the tower and then discharged out of the tower. Dry and wet air refers to the relationship between the air flow in the dry zone and the wet zone. The air first enters the wet zone,

passes through the heat transfer mass, and then enters the dry zone, and then leaves the tower directly after passing through the dry zone.

Condensing Modular Mist Elimination and Water Saving Technology

This technology is equipped with condensing modules (the condensing module has two layouts of ladder and diamond) and water spray filler, the cold air in the environment and the hot and humid air in the wet area are used for wall-type heat exchange to realize the condensation of the hot and humid air, thereby eliminating plume and saving water. As shown in Figure 3.



(Figure 3- condensing module type)

The specific working principle is: cold air is pumped by the fan from the cold air inlets on the left and right sides of the cooling tower and then into the cold channel of the surface type heat exchanger. The hot and humid air passing through the drift eliminator is also pumped into the hot channel of the wall heat exchanger by the fan. The heat of the hot and humid air is transferred to the surface type heat exchanger in the heat channel by convection, radiation and condensation heat release, then through the heat exchanger to the dry and cold air in the cold channel on the other side by convection and radiation heat exchange. After heat exchange, the temperature and moisture content of the hot and humid air are reduced. The moisture content of the dry and cold air is unchanged, but the temperature increases.

The two streams of air continue to rise above the condensing device, and become unsaturated after being fully mixed and discharged through the air duct.

The above two types of plume elimination and water saving are relatively common at home and abroad because of their relatively stable technology and rich experience. Even if many products are different, they are also an extension of these two technical types. Of course, as far as the plume elimination and water saving technology is concerned, people have never stopped researching it, and there have been other various studies. Table 1 shows the contributions made by many Chinese and foreign scholars in the history of cooling tower development.

Table 1 Other anti-plume methods

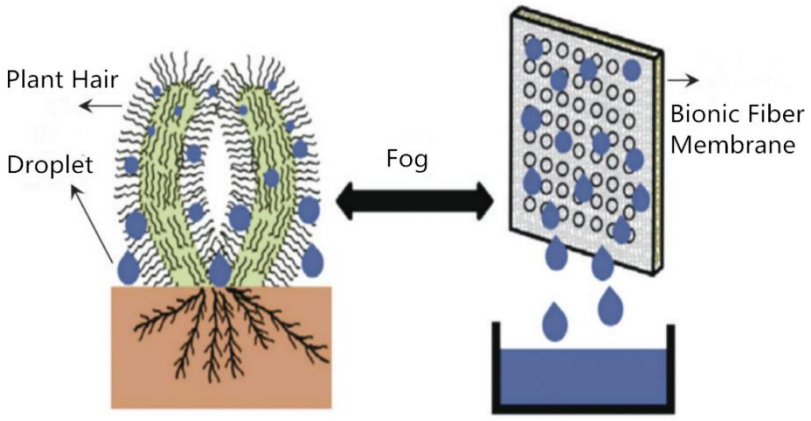
Year	Scholar	Methods	Advice
1970	William etc.	The electric field is used to force the liquid particles in the plume to form a large number of droplets with sufficient mass,so that the droplets can precipitate from the plume under the action of gravity.	This is a physical fog elimination method using electric field Method, the device is complex, and now it is very impractical.
1973	Donn B.Furlong etc.	Announced a cooling tower that changes the normal exhaust temperature and moisture content in order to control or eliminate the mist plume that may occur when the cooling tower exhaust gas mixes with the atmosphere.	At that time, it was a very advanced means of fog elimination, which provided a powerful reference for future generations. But it can't compare with the existing fog elimination methods.
2014	Wang Yue etc.	A water-saving closed cooling tower is disclosed, and the operation mode can be selected according to the different ambient temperature. When the ambient temperature is lower than 5C, the cooling tower adopts air cooling mode to dissipate and cool the medium in the pipe by entering cold air from the air guide slot and discharging hot air from the air outlet; When the ambient temperature is higher than 5C, it is cooled by water cooling.	The cooling tower can dynamically adjust the intensity of heat exchange according to the temperature, greatly improve the efficiency of water resources recycling, and the water-saving effect is obvious.
2015	Sang Moo Shin etc.	Disclosed is a cooling tower with a plume elimination device. The high-temperature cooling water generated by the cooling tower can be converted into low-temperature cooling water through a special structural unit inside the shell, and a special plume generating unit and a plume collecting unit are provided. So as to prevent the production of visible plumes.	The defogging effect is obvious, which can well prevent the generation of visible plume, but the structure of the device is complex.
2020	Ritwick Ghosh etc.	The use of metal mesh to collect water from the fog flow of industrial cooling tower is studied, so as to save water and eliminate fog. The effect of changing the wettability of mesh to change its fog collection is emphatically analyzed. In the literature, orthogonal woven metal mesh (stainless steel grade 304) is placed near the outlet plane of cooling tower, The fog flow is cut off at an angle inclined a to the vertical direction. Through the chemical transformation of the wettability of the metal grid, the fog collection and water collection efficiency of the corresponding metal grid is analyzed through experiments and relevant instruments. It is concluded that the metal grid of HPL-TiO_2 with 15° installation angle has the best fog elimination performance.	This document studies the combination of inorganic chemistry and cooling tower fog elimination and water saving. The article explores the effect of metal grids on the fog elimination and water collection under the transformation of chemical means and analyzes the feasibility of chemical methods. The direction is very novel, which provides great reference value for follow-up scholars

Droplet Capture Technology

The visible plume produced by the cooling tower is a column composed of tiny condensed water droplets. Based on this mechanism, scholars have also proposed a method of catching plume droplets.

M. G ü rsoy, M.T. Harris and others studied the water droplet capture ability and plume collection ability of plant villi,

and proposed a biomimetic fiber network to simulate the ability of plants growing in arid climate to obtain droplets. As shown in Figure 4.



(Figure 4- Demonstration of droplet capture technology)

Scholars proposed that the bionic fiber mesh can be used in cooling tower mist capture, and the mist collection efficiency of this fiber mesh is considerable. In this way, a layer of this bionic fiber mesh can be installed at the outlet of the cooling tower, and the mist droplets can be collected before the hot and humid air is discharged into the atmosphere.

References

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