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Analysis of Water Saving of New Mechanical Ventilation Cooling Tower

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Abstract: In China, the water availability per capita is only 1/4 of the world average. Circulating cooling water, which takes up 60 ~ 80% of the industrial water demands, is lost mainly in the cooling tower. The water-saving eco-friendly cooling tower can save water and remove the mist by the addition of upper air heat exchanger which matches with non-evaporative and evaporative cooling load. This article takes the mechanical ventilation cooling tower as an example for analysis, the main contents are as follows: Compared with the traditional mechanical ventilation cooling tower, the new mechanical ventilation cooling tower has the following innovations: The finned heat exchanger is added to reduce the evaporation loss, and the upper intake air inlet is used to reduce the generation of water mist. In this paper, through numerical simulation and analysis of the benefits, it is found that the new mechanical force ventilation cooling tower has the effect of reducing water loss compared with traditional mechanical ventilation cooling towers.

Keywords: Cooling Tower Water saving Air heat exchanger.

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1. INTRODUCTION

With the increase of China's total population, the acceleration of urbanization and the development of industrial and agricultural production and other industries, the ever-increasing demand for water has made the contradiction between the shortage of water resources and increasing water consumption in China increasingly prominent. How to establish a water-saving economy and water-saving society has become a consensus of the society and is highly valued by the country. The sustainable use of water resources is a strategic issue for China's social development. Its core is to improve water use efficiency and achieve water recycling. Our team believes that the use of cooling towers can achieve the recycling of cooling water. This is an economic and effective measure to save water and energy, which has huge economic and social benefits. What's more, it is also an important way to save water in industry.

In industrial production, circulating cooling water accounts for 60% to 80% of industrial water consumption. At present, wet cooling towers are generally used to cool the circulating water, but the wet cooling tower inevitably generates water loss in the cooling process of the circulating water, including evaporation loss, wind blow loss, and sewage loss. The evaporative

loss water accounts for about 1.2% to 1.6% of the total circulating cooling water, which is the largest of the three losses. The loss of effluent is related to the evaporative loss, and the increase of evaporative loss will inevitably lead to an increase in pollution loss.

New water-saving cooling tower has finned heat exchanger installed in the upper part of the traditional wet cooling tower. An upper air inlet is added at a corresponding position of the tower body, and part of the air enters the cooling tower through the air heat exchanger, and is directly discharged by the fan after mixing with the moist hot air passing through the packing in the tower body. Since the moisture content of the air flowing through the air heat exchanger is the same as the ambient air, the moisture content of the mixed cooling tower outlet air is lower than that of the conventional wet cooling tower, and the generation of water mist can be reduced. At the same time, the air heat exchanger bears part of the cooling load, reduces the cooling load on the filling section, reduces the water loss of the filling section, and can play a water-saving effect.

In the case of scarce water resources, the huge consumption of water in cooling towers has become an urgent problem to be solved. Therefore, it is particularly important to study the new technology of cooling tower water saving and environmental protection. Only by reducing the cooling water consumption of the cooling tower can we improve the utilization of water resources and maintain the sustainable development of the ecological environment.

2. PRINCIPLE INTRODUCTION

2.1 Structure introduction

Fig. 1 is a CAD sectional view. Its main components and parameters are as follows:

(1) Fin heat exchanger: length × width × height = 195 × 45 × 210, heat transfer area 1.1m2, heat dissipation 370W (temperature difference 25 degrees).

(2) Fan, fan blade diameter: 19.5cm, middle round hole: 5.5cm, inner control diameter: 4mm.

(3) Spray pipe, plastic material.

(4) Recirculating water pipes made of stainless steel.

(5) Housing, stainless steel

2.2 Operating principle

The project has changed the cooling tower by improving the structure and working principle of the traditional cooling tower.it also increased the inter wall heat exchanger, achieving the effect of water-saving and defogging. A new type of mechanical ventilation is installed in the upper part of the traditional wet cooling tower, and a special air intake is opened in the side wall of the tower. This air is used to pre-cool the circulating water in the inter wall heat exchanger. Share part of the cooling task to reduce the cooling load of the filler, that is, reduce the amount of water evaporation, so as to achieve the purpose of water conservation. Also, since a dry heat exchanger is provided above the aquifer, the high-temperature near-saturated moist air from the aquarium passing through the packing layer is mixed with the high temperature and low relative humidity air coming from the heat exchanger. Then discharge it from the fan. The relative humidity and dew point of the discharged gas at this time is much

lower than that of the gas discharged from the common pure wet cooling tower, which can greatly reduce the possibility of generating water mist and the amount of water that precipitates when water mist is generated, thereby reducing water mist pollution.

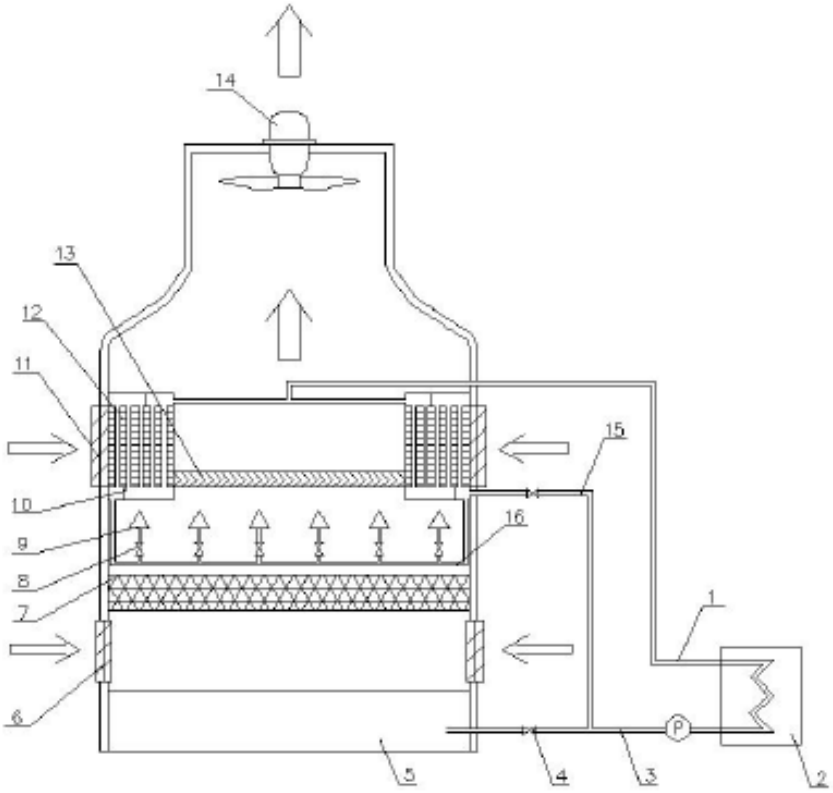


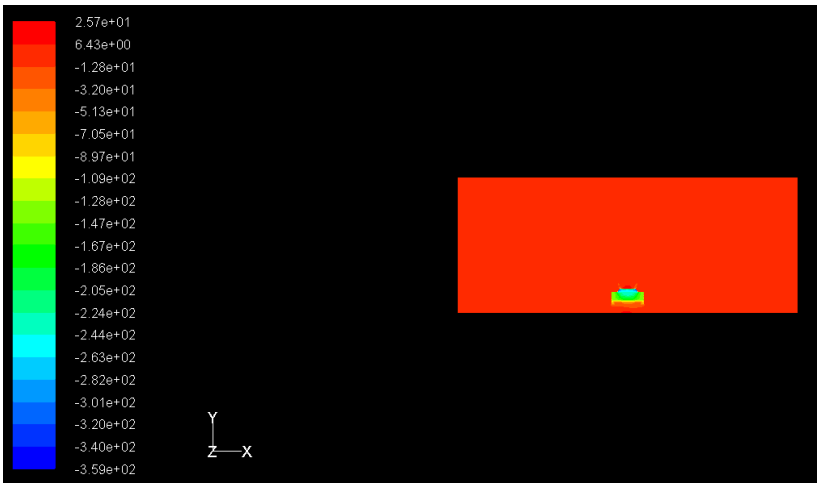
Fig. 1

1 circulating water inlet pipe 2 industrial heat exchangers3 circulating water return pipe 4 control valve 5 water tank6 intake shutters 7 filler8 Control valve 9 Water distributor 10 Set water tank 11 Inlet shutter 12 Air heat exchanger 13 Water trap 14 Fan 15 Bypass16 wall heat exchanger outlet pipes

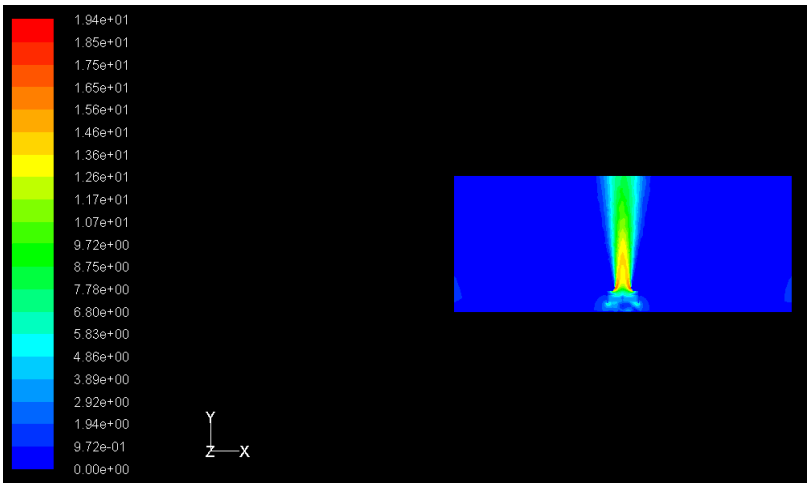
2.3 Numerical Simulation

The experimental water temperature of the tower is within 1K from the water temperature of the simulated tower. The temperature of the dry bulb entering the tower is about 2K lower than the water temperature of the tower, and the temperature of water entering the tower is 8-10K higher than that of the tower. We used the fluent software to perform the simulation. The mechanical ventilation tower without inlet air temperature of 315K was used to simulate the tower water temperature: 310.1K without any wind conditions. The results are as follows:

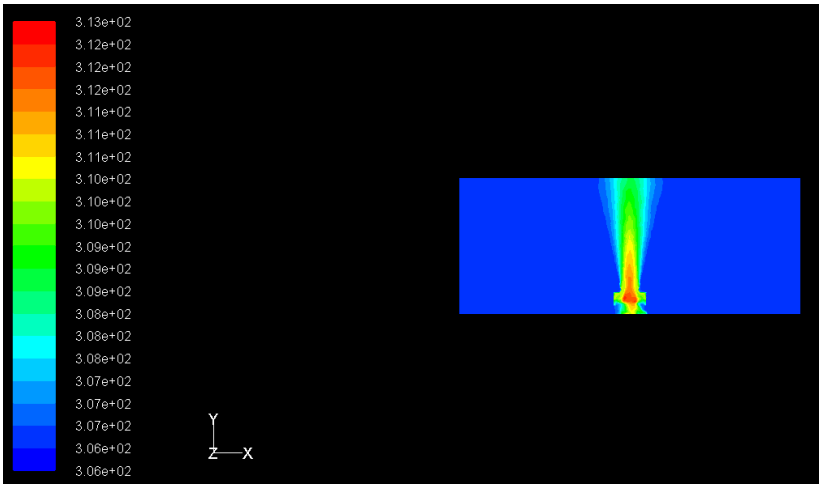
● Pressure cloud map:



● Speed cloud map:



● Temperature cloud map:



2.4 Benefit Analysis

Assuming that the tower enters the heat exchanger with a water volume of 1200 kg/s, the inlet and outlet temperatures of the fin heat exchangers are 42 °C and 40.5 °C, and the mechanical ventilation cooling tower inlet and outlet water temperatures are 42 °C and 32 °C. The water saving rate :

$$1200 \times (42 - 40.5) \div [1200 \times (42 - 32)] \times 100\% = 15\%$$

Water savings are calculated as follows:

The cooling tower circulating water volume is 1200kg/s. The inlet and outlet water temperatures are 40 °C and 36 °C. Check the table to find that the Ke for the dry bulb temperature of 5.0 °C is 0.11. According to the operating conditions of the evaporating operation for 4 months in winter, the evaporating water volume is:

$$1200 \times 1000 \div 3600 \times 0.11 \times (42 - 32) \div 100 \times 120 \times 24 = 10560\text{t}$$

the water saving capacity is

$$10560 \times 15\% = 1584\text{t}$$

3. CONCLUSION

(1) Finned heat exchanger - reduce evaporation loss

The new water-saving environmental protection cooling tower has a finned heat exchanger installed in the upper part of the traditional wet cooling tower. The finned heat exchanger bears part of the cooling load, reduces the cooling load on the filling section, reduces the evaporation loss of the water in the filling section, and can play a water-saving effect.

(2) Set up the air inlet - reduce the generation of water mist

A new type of water-saving and environment-friendly cooling tower has an upper air inlet at the corresponding position of the tower body. Part of the air enters the cooling tower through the air heat exchanger and is directly mixed with the hot and humid air flowing through the packing in the tower body and discharged by the fan. Since the moisture content of the air flowing through the air heat exchanger is the same as the ambient air, the moisture content of the mixed cooling tower outlet air is lower than that of the conventional wet cooling tower, and the generation of water mist can be reduced. Plays a water saving effect.

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