Numerical Analysis and Optimization Research on Backflow Effect of Cooling Tower

Xiu Xiong\textsuperscript{a}, Li Li\textsuperscript{b}, Xiao-qing Zhou\textsuperscript{c,*}

\textsuperscript{a} College of Civil Engineering, Guangzhou University, Guangzhou 510006, China; \\
\textsuperscript{b} College of Architecture and Urban Planning, Guangzhou University, Guangzhou 510006, China; \\
\textsuperscript{c} Institute of Building Energy Efficiency, Guangzhou University, Guangzhou 510006, China

Abstract

Cooling towers are generally arranged in a hidden area, since it is necessary to consider the appearance and space of the building, as well as to avoid the effects of running noise in the surroundings. In the project to take into account the layout of the cooling tower, which will affect the hot and humid air backflow, the cooling tower will increase the temperature and humidity, while deteriorating the surrounding micro-environment, directly affect the performance of the cooling tower. Cross-flow cooling tower air enters through the side of the tower, counter-flow cooling tower air enters through around the lower part of the tower. In this paper, the numerical simulation method is used to analyze the backflow of counter-flow and cross-flow cooling tower. By comparing the two air inlet temperature, this article judge the two tower backflow situation, and proposed optimization measures to reduce backflow. The simulation shows that the intake air temperature and return rate of the counter-flow are lower than those of the cross-flow, because the counter-flow arrangement makes the inlet airflow more uniform and the exhaust wind speed is large. As cross-flow air backflow of the situation is more serious, so done optimization for cross-flow cooling tower, including the outlet tube plus 15° upward louver and plus 2.2 meters air louver inlet, and simulation shows measures effectively reduce the backflow. The results can provide a reference for engineering design to reduce adverse design effects due to improper cooling tower design.

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Peer-review under responsibility of the scientific committee of the 10th International Symposium on Heating, Ventilation and Air Conditioning.

Keywords: cross-flow cooling tower; counter-current cooling tower; cooling tower backflow rat; layout; CFD

* Corresponding author. Tel.: +133 4288 4448.
E-mail address: zhou_xiaoqing03@163.com (Xiao-qing Zhou)
1. Introduction

Cooling tower is an important large-scale equipment in central air conditioning system, which makes a great effect on air conditioning system cooling efficiency [1]. The arrangement of the cooling tower is an important factor for performance of the cooling tower [2]. Due to the architectural beauty and site constraints, the cooling towers are usually arranged in the podium, the main building roof, etc [3]. In order to avoid the impact of noise in the surrounding environment, the cooling tower is blocked. Which may lead to hot and humid air backflow due to natural wind or inlet suction, and interfere with the hot air from the nearby towers, as shown in Figure 1[4].

![Figure 1](image1.png)

**Fig.1. Schematic diagram of cooling tower backflow and interference (a)Backflow ;(b)Interference.**

If the hot and humid air backflow rate is high, with tower’s long-term operation, the continuous backflow of hot and humid air will lead to cooling tower air inlet temperature and humidity gradually increased, cooling tower cooling effect will decline; the same time, it also will affect the surrounding crowd comfort. Research has shown that [5], when the backflow rate increased to 50%, outlet water temperature increased by 9.16%, heat transfer reduced by 40.68%, dry bulb temperature of outlet air is 2.18%, relative humidity of outlet air increased by 10.4% and the comfort index changes 1.92.

The complexity of the environment in which the cooling tower is located is difficult to rely solely on engineering experience for analysis. Compared with the field, the model experiment measurement, using CFD technology for numerical simulation analysis, which has the advantages of low cost, comprehensive analysis of data, short time required [6]. In the project, about the cooling tower layout, CFD can be used to simulate the feasibility of the program, Compare the ventilation and backflow conditions of the cooling tower in the building environment, optimize the program, to select the best way to arrange the cooling tower. Next, CFD software PHOENICS was used to simulate the engineering project.

2. Project summary

The project is to set up cooling tower of business district, which is placed on a podium roof. Surrounded by walls closed, to reduce the impact of noise on residential areas 20 meters away, the top made a soundproof seal. The outer wall opening as the cooling tower into and out of the air channel, it is separated from the middle by 8.2 meters wide, 10% slope of the ramp is divided into two channels, the upper half is the outlet channel and the lower half is the inlet channel. Cooling tower outlet installed duct, which can avoid the hot and humid air interference between the towers; the inlet and outlet of the cooling tower are separated by walls and slope, which helps to reduce the return flow. The counter-flow and cross-flow plated on first floor podium roof layout appearance shown in Figure 2.
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