Dehumidification Performance Analysis of Solution Dehumidifier Based on Fluent

Tianyi Han

Shandong University of Science and Technology, Shandong 266590, China;

3107225162@qq.com

Abstract

In this paper, a certain type of solution dehumidifier's internal gas flow is analyzed by Fluent software, and dehumidification performance of the dehumidifier is studied. Obtained the influence of gas inlet size and the distance between wet film and gas inlet on dehumidification performance. The results show that dehumidification performance of dehumidifier is better with the increase of gas inlet size and the distance between wet film and gas inlet.

Keywords

Solution dehumidifier, finite element, dehumidification performance analysis.

1. Introduction

Dehumidifier is a very important part of industrial environment control system. As the core component of dehumidifier system, Its dehumidification performance determines the humidity of environment directly.In recent years, with the continuous development of dehumidification technology, a variety of dehumidification methods have been constantly studied.Solution dehumidification has been widely used for its advantages of using low-grage energy, simple operation, cleanliness and excellent environmental protection performance [1,2,3,4].In this paper, a certain type of solution dehumidifier is taken as the research object.The distribution of gas flow inside dehumidifier was studied by Fluent software,on this account study the factors affecting dehumidification performance of dehumidifier.

2. Dehumidifier structure

The dehumidifier that studied in this paper dehumidify internal gas by combination of dehumidifying solution and wet film.The monolithic construction of dehumidifier is a cuboid shell structure, its interior is equipped with a dehumidifying wet film, wet film structure is shown in figure 1.A dehumidification solution spray device is installed above the wet film. Gas is inhales into dehumidifier through the fan installed at the outlet and dehumidify in dehumidifier.The general structure of the dehumidifier is shown in figure 2.

Fig. 1 Internal wet film of dehumidifier

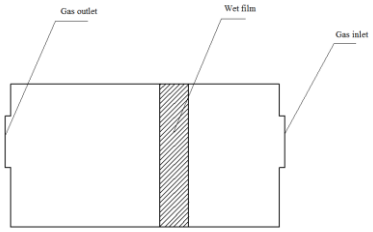

Fig. 2 Dehumidifier structure

3. Analysis on the influence factors of air distribution in dehumidifier

Before studying the factors affecting dehumidification performance of dehumidifier, we need to analyze gas distribution of dehumidifier first, In this paper, we take dehumidifier middle cross section of horizontal direction as research model. By analyzing the distribution of gas flow on this plane, the factors affecting dehumidification performance of dehumidifier are studied. Using AutoCAD software to draw the internal frame and wet film structure of dehumidifier. Taking the pressure differential which the fan is at maximum power as the pressure differential between gas inlet and outlet of dehumidifier. The flow direction and velocity of gas in the dehumidifier are obtained by using Fluent software for finite element analysis. The results of gas distribution finite element analysis inside the dehumidifier are shown in figure 3.

The overall length of dehumidifier is 1300mm, gas inlet and gas outlet both are square, gas inlet's length and width are 700mm and gas outlet's length and width are 900mm. The pressure difference between inlet and outlet is 600Pa, and wet film is 500mm from gas inlet. According to fig. 3, it is found that gas has obvious diffusion after entering inlet, and gas in the middle part of box is slowed down due to diffusion. However, gas flow velocity in the middle of part is faster and decreases gradually to the two sides. This is because that gas velocity in the middle part of wet film is perpendicular to wet film, and gas does not collide with wet film. Gas flow on both sides of wet film is not perpendicular to wet film because of diffusion. Gas collides with wet film, causing gas velocity decrease. Gas is gathered near the outlet, and gas flow rate is increased. According to the above analysis results, we can know that if we want to improve the dehumidification performance of wet film, we must improve the distribution uniformity of gas flow through wet film. Considering that the attenuation of gas velocity on both sides of the wet film is caused by gas diffusion, reducing gas diffusion is a way to improve the dehumidification performance of wet film. It can be improved by increasing the size of the gas inlet and the gas diffusion distance in two ways.

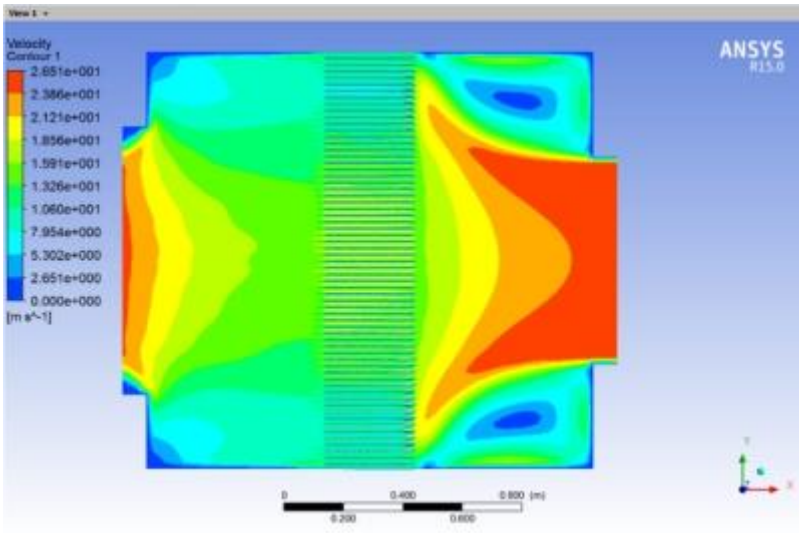

Fig. 3 Nephogram of gas flow velocity in dehumidifier

3.1 Increase the Size of Gas Inlet.

In order to reduce gas diffusion from gas inlet, it is a good choice to increase gas inlet size. Expanded the dehumidifier gas inlet from 700mm to 900mm, the gas flow rate nephogram obtained by Fluent software is shown in figure 4.Compared with figure 3, it is obvious that gas diffusion is improved, and flow velocity on both sides of wet film is more uniform than previous velocity. This is because of after the gas inlet expansion, the angle of air flow diffusion is smaller than before, the degree of collision between gas and wet film on both sides of the wet film is reduced. Gas flow rate has not been reduced too much. The more uniform gas passes through wet film, the more efficient wet film will be. And the better dehumidification performance of dehumidifier is.

3.2 Increase the Gas Diffusion Distance.

Another way to reduce gas diffusion is to increase the distance of gas diffusion. Increase the distance between dehumidifier wet film and gas inlet from 500mm to 1000mm. The length of the entire dehumidifier is also increased, and the finite element analysis is carried out with Fluent software. The obtained nephogram are shown in figure 5. Compared with fig. 3, gas flow is more uniform when passing through wet film. This is because the time of gas diffusion is increased with the increase of the distance between wet film and gas inlet. The change rate of gas flow direction is not so intense. The collision degree of wet film's two sides decreases, and the decrease of the gas flow rate is not obviously, the uniformity of gas distribution is enhanced, and the dehumidification performance of dehumidifier is also improved.

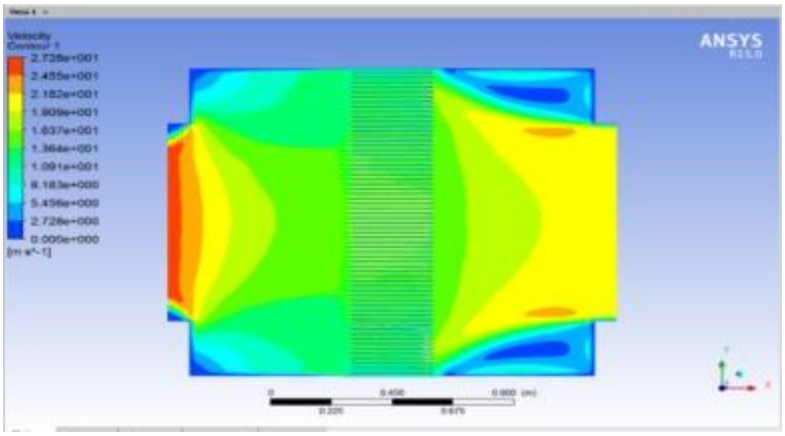

Fig. 4 Nephogram of gas flow velocity after expanded inlet

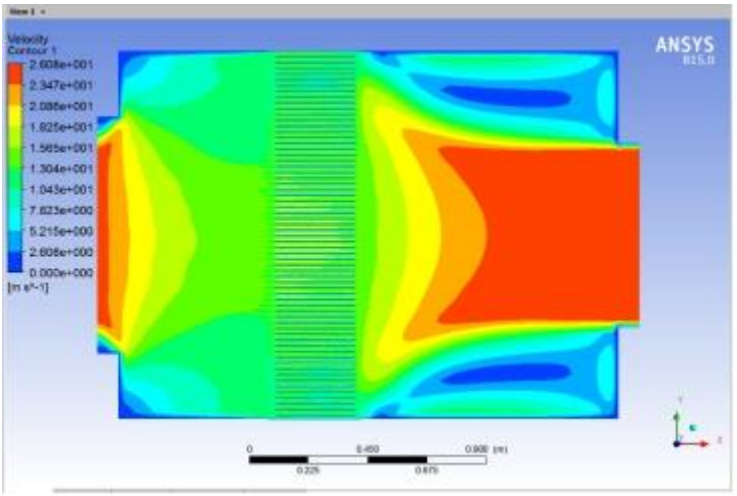

Fig.5 Nephogram of gas flow velocity after increased the distance

3.3 Gas Inlet Size and Gas Diffusion Distance Increase Simultaneously.

The two methods both can improve the dehumidification performance. The combination of the two methods will further improve it. Expanded the dehumidifier gas inlet from 700mm to 900mm, and increase the distance between dehumidifier wet film and gas inlet from 500mm to 1000mm. The finite element analysis is carried out by the Fluent software, and the nephogram is shown as shown in figure 6. As we can see from the diagram, the diffusion of gas after entering the inlet is very slow, and the velocity of gas is very uniform when it passes through wet film. Compared with figure 3, the improved result is very obvious. It is proved that with the increase of the gas inlet size and the distance between wet film and gas inlet, the uniformity of the gas flow velocity inside the dehumidifier increases.

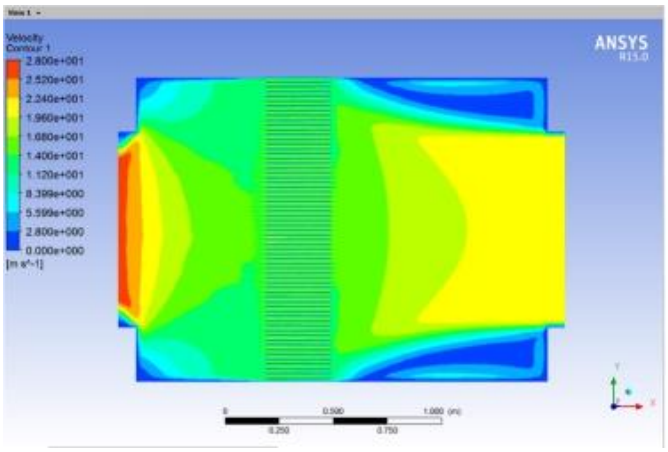

Fig. 6 Nephogram of gas flow velocity with using two methods together

3.4 The Relationship between Gas Distribution and the Influencing factors

According to the analysis results,we can find that with the increase of the dehumidifier inlet size and the increase of the gas diffusion distance, the gas flow velocity will be more uniform when the gas is passed through wet film, both of which have a positive correlation to the uniform distribution of gas. The effect can be expressed in formula 1, where the influence coefficient k1 and k2 are greater than zero.

$$M = k_1 X + k_2 Y. \quad (1)$$

M: The uniformity of the velocity when gas pass through wet film

X: The dehumidifier inlet size

Y: The gas diffusion distance

k1 k2: The influence coefficient

4. Conclusion

In this paper, the influence of dehumidifier inlet size and the distance between wet film and dehumidifier inlet on gas flow velocity is studied. Though finite element analysis with Fluent software, the factors that can affect dehumidification performance are stuided. The analysis results show that gas flow velocity in dehumidifier will be more uniform with the increase of the dehumidifier inlet size and the distance between wet film and dehumidifier inlet, thus the dehumidification performance is improved. The results of finite element analysis in this paper provide reference value for subsequent design and improvement of dehumidifier.

References

[1] L. Chen, Q. Chen, Z. Li, et al. Analysis of Solution Dehumidification Performance and Optimization of Wet Resistance Method , Chinese Science Bulletin,vol. 55 (2010), 1174-1181.

[2] B.C. Gao, G.Q. Yu, S.L. Gao: The Simulation Analysis of Counterflow Solution Dehumidifier Performance, Refrigeration and Air Conditioning, vol. 27 (2013), 101-105.

[3] Z.J. Huang, P. Jiang, L.N. Zhou. Theoretical Analysis and Numerical Simulation of Complex Heat and Mass Transfer Between Air and Desiccant in Liquid Desiccant Dehumidification, Fluid Machinery, vol.42 (2014), 67-712.

[4] X. Wang, J.H. Liu, Y.J. Zhao, et al. Study on the Performance of Dehumidifier with Liquid Desiccant, Journal of Refrigeration, vol.2 (2017), 45-50