CS144

Effects of environmental wind on natural smoke exhaust in a tunnel with one blocked end

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Abstract

In order to investigate the effect of environmental wind on a tunnel with one blocked end fire under natural ventilation, a series of numerical simulations were conducted using large eddy simulation method in this study. The tunnel model is established by using the numerical simulation software FDS, and 36 groups of working conditions such as wind speed of 0-5 m/s and wind angle of 45-135° are simulated. Combined with the simulation results of smoke spread, temperature and velocity vector, the smoke flow characteristics and temperature distribution characteristics in the tunnel with one blocked are analyzed, and some effects of the changes of ambient wind speed and direction on natural smoke exhaust in a tunnel with one blocked end are obtained.

Introduction

In order to improve and supplement the existing research on tunnel ventilation and smoke exhaust, it is necessary to study the smoke flow characteristics in the tunnel under the influence of ambient wind in detail. Therefore, in this study, a series of simulations were carried out through FDS to study the influence of ambient wind on smoke flow characteristics of natural ventilation in a tunnel with one end blocked.

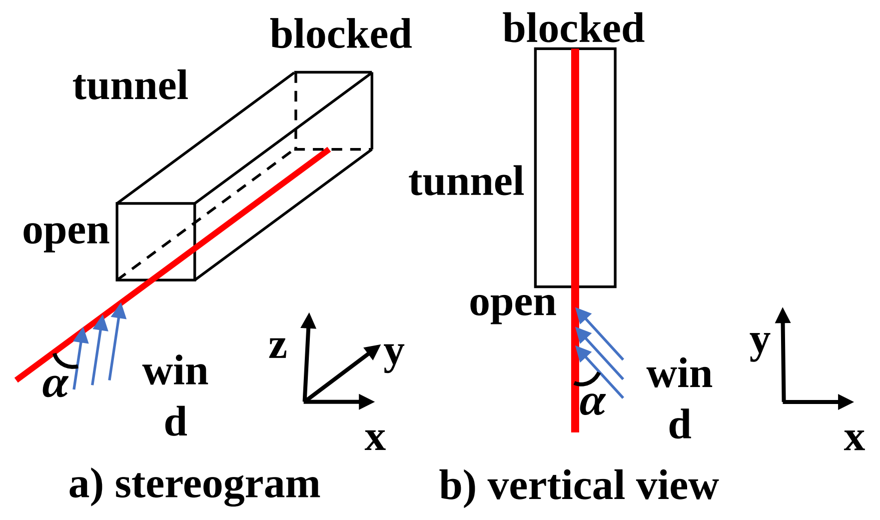
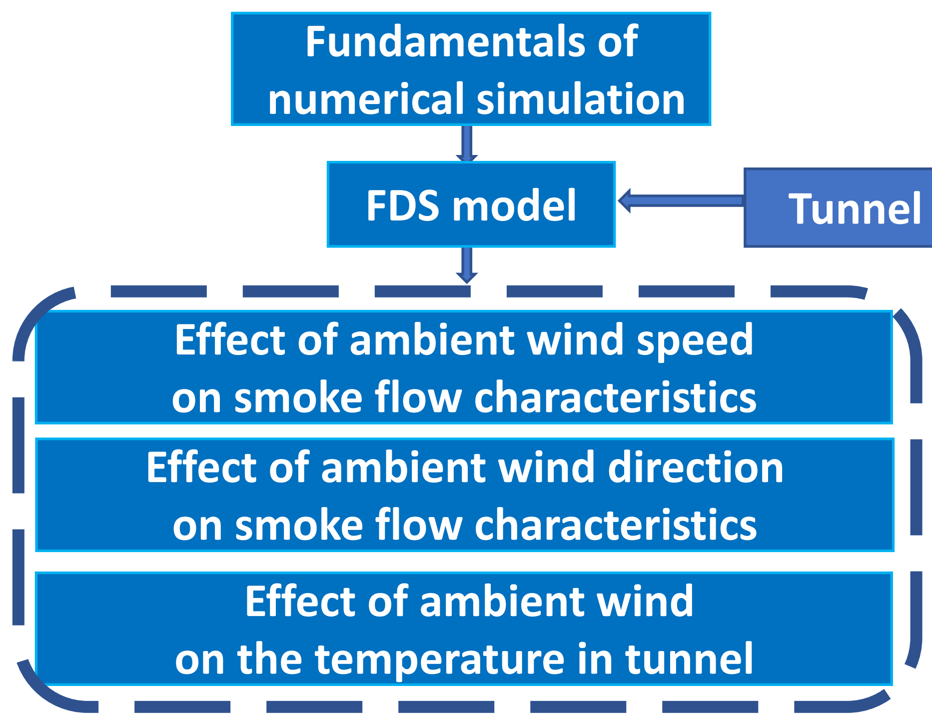


Figure 1. Direction of ambient wind

Methods



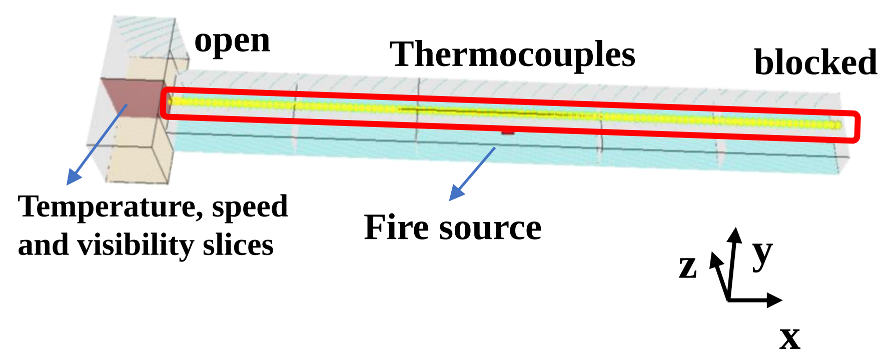


Figure 2. FDS model configuration

Results

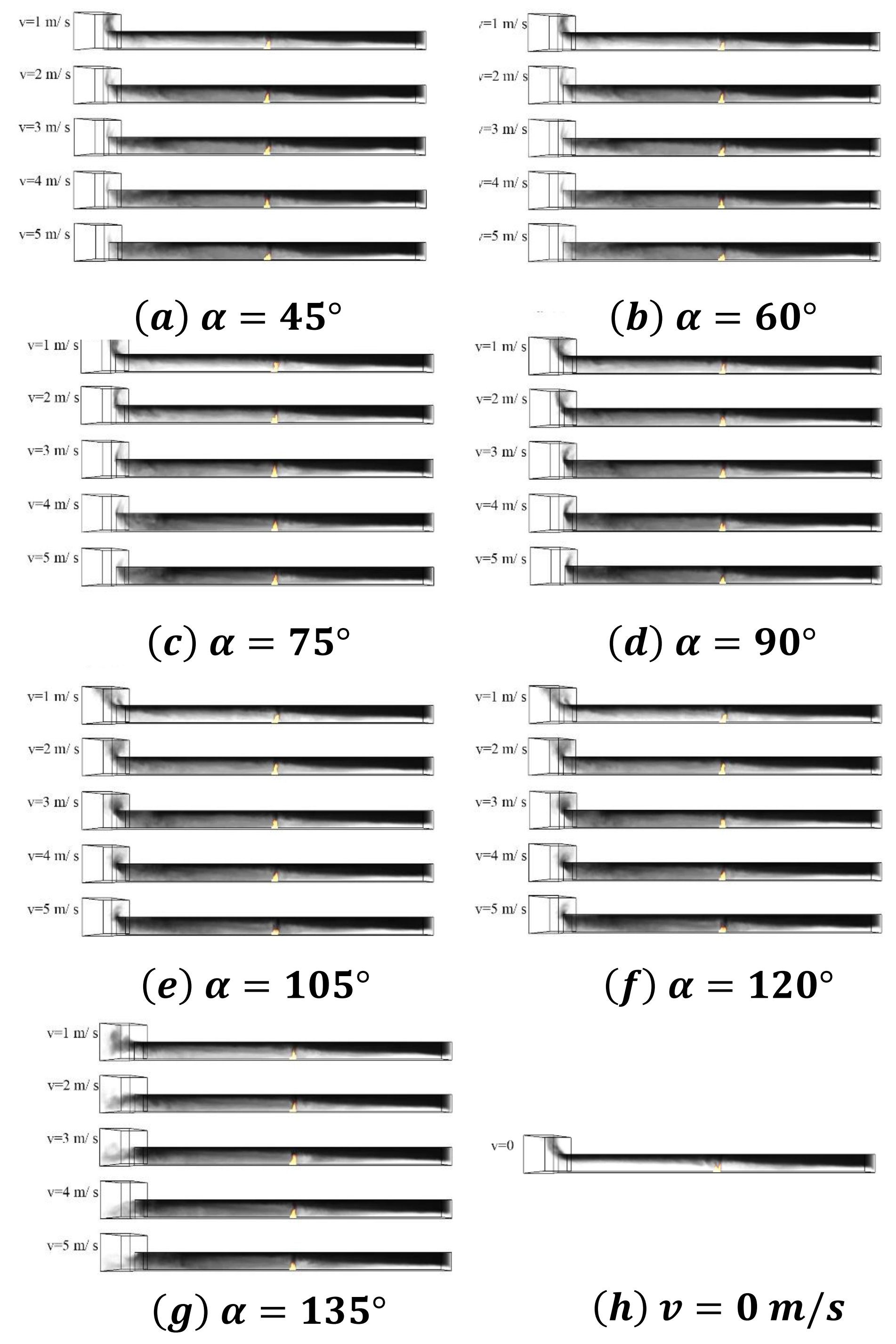


Figure 3. FDS model configuration

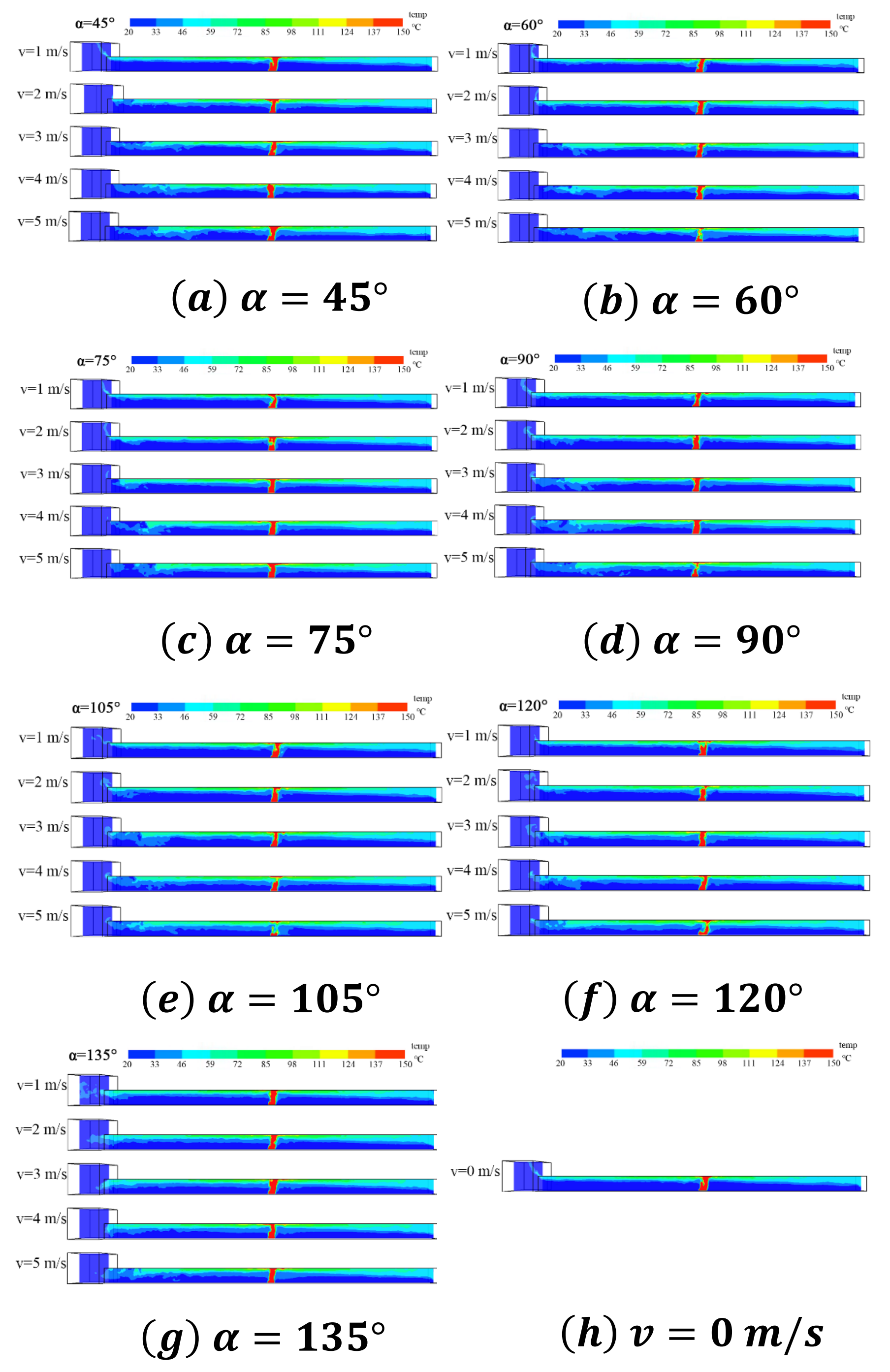


Figure 4. Temperature distribution in Y=5 m slice

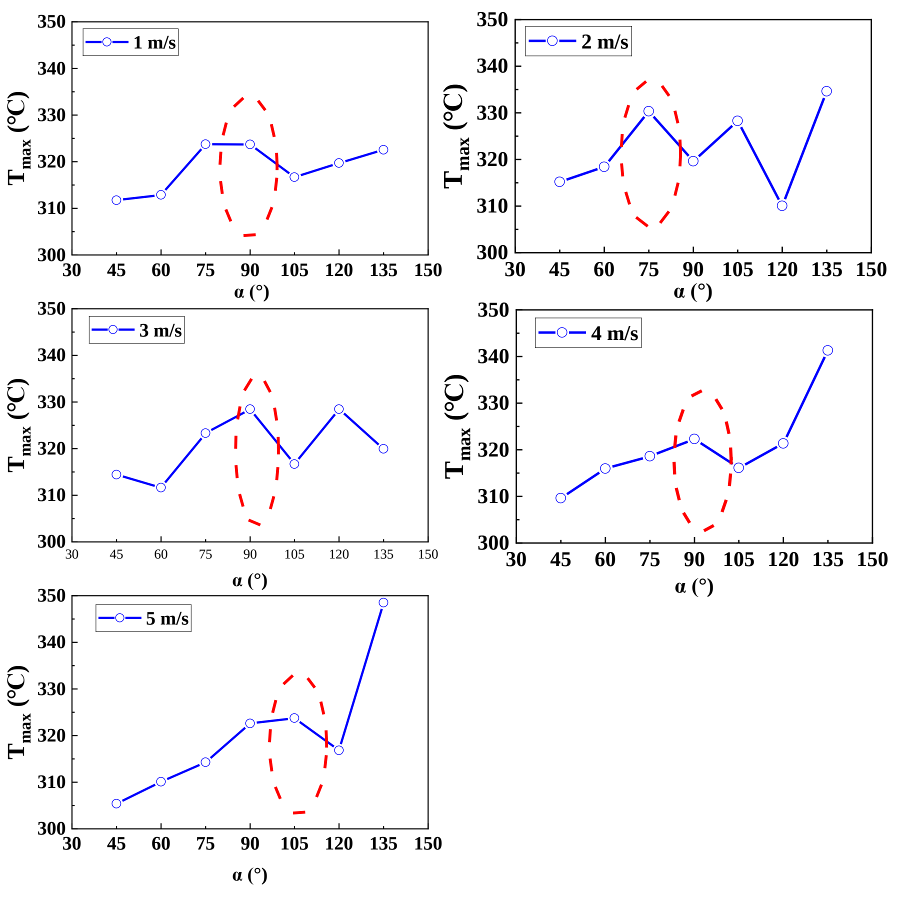


Figure 5. Maximum ceiling gas temperature

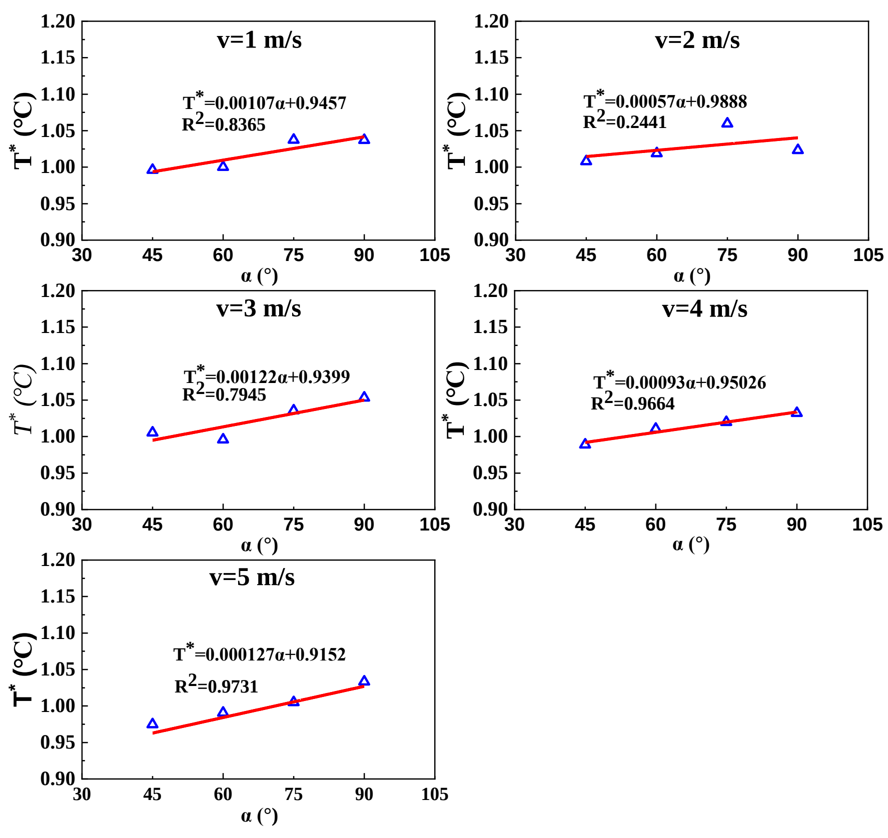


Figure 6. Dimensionless ceiling maximum temperature rise in different ambient wind velocity

Conclusions

- With the increase of wind speed v, the disturbance degree of air flow in the tunnel blocked by ambient wind increases, and the difficulty of smoke natural discharge increases accordingly.
- When $45° \leq \alpha \leq 135°$, the natural smoke exhaust capacity in the tunnel sealed at one end increases with the increase of α.
- With the increase of wind speed v, ambient wind is more likely to enter the tunnel and mix with the smoke flow, making the vertical distribution of temperature near the open end of the tunnel more uniform.
- When the wind direction Angle α is within 45°~135°, the maximum temperature of tunnel ceiling has an increasing trend with the increase of α.
- under the experimental conditions of this paper, dimensionless ceiling maximum temperature rise T^* in one end blocked tunnel follows vary linearly with angle α.