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Influence of Solar Incidence on Thermal Environment of Passenger Compartment

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ABSTRACT: The solar radiation has a very important influence on the thermal environment of the passenger compartment. Reducing the solar radiation is beneficial to improve the thermal comfort of the occupants. Considering the solar radiation, conduction and natural convection, the temperature field of the passenger cabin model in a region under the solar radiation in summer was simulated, and the temperature variation in the room with or without solar radiation was analyzed. The results show that the characteristics of the window glass have a significant influence on the temperature inside the car.

Keywords:solar radiation, heat transfer, numerical simulation

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I. INTRODUCTION

The thermal comfort of the occupant in the car compartment is mainly determined by the distribution of heat flow field around the human body, while the thermal environment in the interior of the car is greatly influenced by the external environment [1]. How to reduce the influence of the outdoor environment, especially the solar radiation on the cabin thermal environment, is the focus of this paper. In recent years, a lot of researches have been done on the thermal comfort of car riding. The effects of air conditioning, occupant and external environment on the flow field and temperature field in the vehicle were analyzed by means of experiments and numerical methods in reference [2-5]. The [6-10] analysis of the effect of solar radiation on the thermal environment of the passenger car compartment, but are just unilaterally on automobile air conditioning in summer on solar radiation after the vehicle thermal comfort becomes poor, not only by considering the solar radiation exposure to natural conditions of solar radiation change on indoor air temperature in the car. Firstly, the automobile passenger compartment heat transfer numerical simplified calculation model, simulation calculation under certain weather conditions, the heat exchange process of the external environment and the automobile passenger compartment, and then analyzes the effect of solar radiation on the indoor temperature, in order to improve the vehicle ride comfort design reference.

II. ESTABLISHMENT OF NUMERICAL MODEL

2.1 Geometric simplification

This paper takes a car as the research object, because the engine room, the trunk and the wheel have little influence on the flow field inside the car, so as to reduce the meshing time, simplify the processing. When the model is built, the details of the body structure can be simplified, and the details of the car body accessories can be neglected. In order to analyze the influence of solar radiation on the thermal environment of cars, two kinds of 3D models with window and windowless model are established. Schematic diagram of fully enclosed passenger compartment model, is shown in Figure 1 and schematic diagram of semi enclosed passenger compartment model, is shown in figure 2.

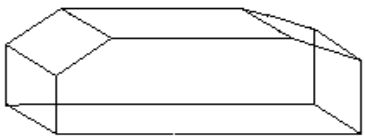

Figure 1 Schematic diagram of fully enclosed passenger compartment model

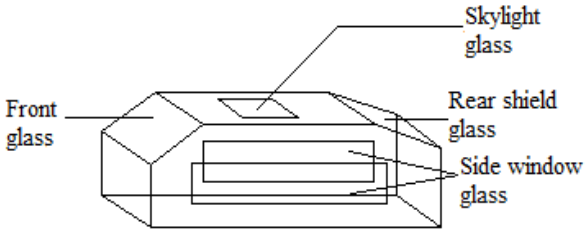

Figure 2 Schematic diagram of semi enclosed passenger compartment model

2.2 simulation running environment and boundary conditions

The numerical model includes discrete mesh model, physical property and surface parameter and weather environment parameter. In the vehicle flow field, the air velocity is relatively small, the air density changes little, can be approximately constant, the indoor air can be regarded as three-dimensional incompressible flow field.

The numerical simulation of the thermal environment in the car compartment is mainly affected by the solar radiation, so the sun angle is accurately set. The selected simulation location for Shanghai, located in the East District 8, 31 degrees north latitude, longitude 120 degrees, the car parked in the front direction to the south, the date for June 21st, time is 12:00 noon, atmospheric transmittance is 0.7.

In normal condition, the heat transfer mode between the car body and the outside body is the mixing condition of radiation and natural convection. In the simulation, the Mixed boundary condition is set up between the body and the external heat transfer. The parameters to be set include the convection heat transfer coefficient, the free flow temperature and the external radiation temperature, so the wall thickness should be set for considering the wall thermal resistance.

III. RESULT AND DISCUSSION

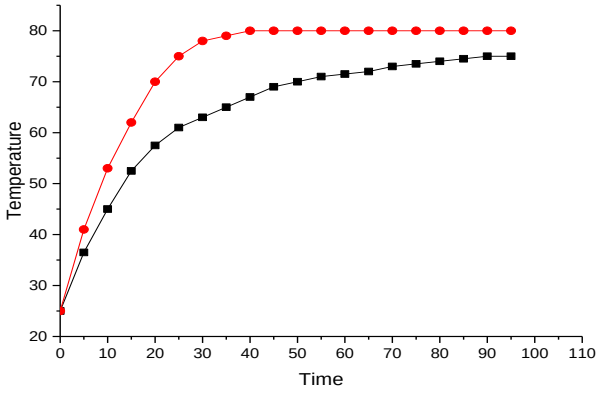

Figure 3 Temperature variation curve

Figure 3 shows the temperature variation curve of the monitoring points of two models with windows and windows without solar radiation. Visible indoor temperature change with the irradiation time, the rising initial stage temperature rise faster, after a period of time the temperature monitoring value remained stable at a certain temperature, the internal temperature field that cab reached a state of relative balance. The monitoring point of the car with a window model can reach the steady state within 40 minutes, and the temperature of the monitoring point is about 80 degrees Celsius at the steady state. The monitoring point of the windowless model reaches steady state within 90 minutes, and the temperature of the monitoring point in the vehicle is about 70 degrees centigrade at steady state.

IV. CONCLUSION

The solar radiation is the most important factor affecting the internal thermal environment of the car. Due to the influence of solar radiation, the temperature distribution in the car room is obviously inhomogeneous, and the temperature at the direct solar spot is obviously higher than that in other parts of the car. In order to

ensure the thermal comfort of occupants, it is necessary to adopt the appropriate automobile air conditioning to heat the forced convection heat inside the car to achieve the appropriate vehicle temperature.CFD calculation can predict the temperature field and flow field distribution in the cockpit, and has practical guiding significance in the study of cabin cabin thermal comfort.

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