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Air Conditioning Design for Comfort Impact on the Human Body in Small Vehicles

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Keywords*— *Car Air Conditioning, Human Comfort, PMV, PPD

***Abstract*— *This paper uses the theory of Heat Exchangers to estimate the relationship between the outlet and the inlet and is written in conjunction with Fluent to simulate the impact of the air conditioning system on the environment in the car. The outside environment also affects the inside of the car, and this paper experiments to obtain outlet environment data and set it as the boundary conditions. The thermal comfort index in this paper will use experimental parameters to compute the results and analyze the results of the data to address people's requirements for the quality of the driving environment and provide a better driving environment.*

I. INTRODUCTION

In vehicle design, thermal comfort not only affects the immediate feelings of passengers but is also closely linked to driving safety, health, and energy efficiency [1]. An appropriate temperature in the car reduces the driver’s feeling of fatigue and increases his attention and response speed, thereby reducing the risk of traffic accidents. In addition, at comfortable temperatures, the body’s physiological function is more stable and can effectively avoid physical discomfort caused by heat or overheating, such as colds, strokes, or joint pain [2]. From an energy-efficient point of view, a reasonable heat comfort design can optimize the use of the air-conditioning system, reduce unnecessary energy consumption, and have a positive impact on environmental protection and the economy.

The in-room heat comfort model is a very important technical problem in the design of an in-room heating and air conditioning system [3]. The model is composed of two parts, namely, the Model of Calculation of the Comfort of the Heat Environment in the Car and the Model for Calculating the Comfortable Heat in the Car [4]. The first one is studied by three professors, Wang Baoguo, Jin Yanmei and Liu Shuyan. This model is mainly aimed at the problem of the thermal comfort of the human body in the car. The model uses the Calculative Model of Comfort in the Thermal Environment and the calculative model of the assessment of the caloric comfort in the body of the car under the Non-uniform Thermal Comfort Environment proposed by three professors. It can analyze and predict the heat comfort problems of the whole car room. This has an important role in improving the structure and design of the air conditioning system in the vehicle.

With the advancement and development of modern computer engineering science technology, computer technology can be used to solve fluids that meet various constancy conditions controlled by partial equation groups. The mathematical calculation of indoor flow has also made great progress and development in the technology of fluid mechanics. CFD methodology is currently a strong engineering scientific research and application field internationally and is the core and important technology for air conditioning systems to conduct "three transmissions": heat transmission, transmission of motion and indoor air combustion, multi-phase flow, and chemical reaction engineering research [5].

Using the fluid mechanics CFD method, we can simulate and predict the phenomena of the speed field, temperature field, humidity field, and hazardous concentration fields of indoor air flow. This not only achieves the overall performance of the air conditioning system that can be simulated and forecast indoors, but also the possibility of multiple virtual product developments in the interior, which greatly reduces the number of actual trials, the cost of trials, and the shortening of trial cycles.

Therefore, using the CFD model and FLUENT simulation, numerical simulation experiments can be performed faster and faster. The known in-car environment analysis is closely related to the impact of the air-conditioning system in the car and the outside environment. For the in-vehicle air conditioning system, the theory of Heat Exchangers is used in this paper to estimate the relationship between the outlet and the back outlet of the car [6]. For an outside environment, this paper uses the values obtained from the real car experiment as the boundary conditions. In addition, consider the k-ε mode and the heat transmission of the cabin. The above conditions are introduced into the FLUENT simulation software to obtain changes in the temperature field and the speed field of the vehicle, and the results are predicted by the thermal comfort index PMV forecast method to predict the passenger's heat comfort and build a set of heat comfort software to analyze the comfort of the environment inside the car.

With the model of the bridge car containing air conditioning, this study is mainly divided into the following four aspects for improving the problem of human heat comfort in cars: (1) Based on the theory of fluid fluid viscosity, the RNG k-ε fluid model has been used to calculate the air flow and temperature distribution in the car room. (2) In order to reflect as much as possible the authenticity of the physical model, the effects of various heat loads on the in-vehicle flow fields were taken into account in the establishment of the mathematical model, and the biological thermal boundaries were considered. (3) the construction of a common car physics model with the appropriate simplification of the area of study in order to study the effect of solid regions on the distribution of air flow speed in the vehicle room. (4) use FLUENT software for numerical simulation of the air conditioning car room; study to analyze the change in the air flow field in the car room when different ventilation positions and ventilation parameters are used; compare the various air flow organizations; and provide a reference for optimization of design.

II. EFFECTS OF HEAT LOADS ON HUMAN COMFORT

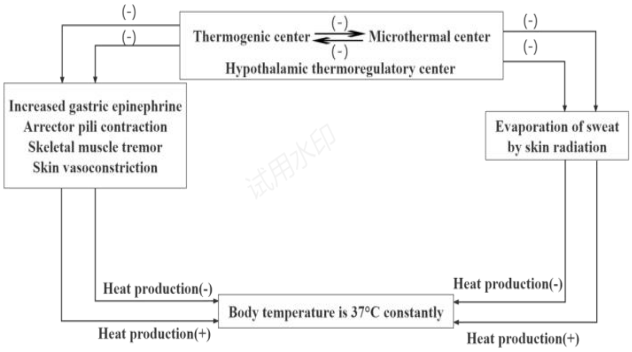
The energy balance equation of the human body and its surroundings is based on the energy equilibrium equation developed in the ASHRAE Handbook of Fundamentals [7] :

$$M - W = Q_{sk} + Q_{res} + S = (C + R + E_{sk}) + (C_{res} + E_{res}) + S_{sk} + S_{cr} \quad (1)$$

Among these are: M-human metabolism rate, (W/m^2); W-humane metabolism, (W/m^2); Q_{sk}-heat loss caused by skin, (W/m^2); Q_{res} -thermal loss caught by respiration, (W/m^2); S-heating energy stored by the human body, (W/m^2); C-heater loss cause of fluid in the skin, (W/m^2); R-heather loss causse of radiation in skin, (W/m^2); C_{res}-Heat Loss from Respiration, (W/m^2); E_{sk}-Heat loss due to evaporation from skin, (W/m^2); E_{res}-Heating loss caused by evaporating breathing, (W/m^2); S_{sk}-Heat storage from skin, (W/m^2); S_{cr}-Heating storage in the body, (W/m^2).

In general, the body temperature is maintained at approximately 37 °C [8], and when the temperature of the body falls below the external ambient temperature, it is controlled by some mechanisms to maintain the temperature. The body's temperature adjustment system, based on equation (1), controls the temperature at a constant temperature, avoiding too high or too low temperatures.

When the body temperature is too high to reduce the heat loss rate, the blood vessels shrink and change the blood flow rate. The heart also slows down its beat rate, and with the evaporation of sweat, the temperature decreases [10]. On the contrary, when the body's temperature is so low, the body produces unself-sufficient muscle tremors to increase heat loss, resulting in a rise in body temperature.



试用水印

Fig.1: Human thermal balance ratio chart (representing- decrease, +increase)

2.1 PMV indicators

The most common and widely used indicators for assessing thermal comfort are *PMV* (predicting average voting) and *PPD* (predictive dissatisfaction percentage). The *PMV* indicator is used to measure the comfort of a person in an environment [10], generated by a subjective assessment by many subjects of certain environmental conditions in a particular environment. In order to take into account the differences among different individuals, the *PPD* indicator has been developed in the form of percentages to represent the proportion of individuals who will feel dissatisfied under the same conditions.

The *PMV* indicator is proposed by *Fanger* [10–11], controlled by the six parameters of air temperature, relative humidity, average heat radiation temperature, clothing thermal insulation value, degree of human activity, and relative air flow rate. The theoretical formula is:

$$PMV = (0.303 \cdot e^{-0.036M} + 0.028) \times \left[(M - W) - H - E_c - C_{res} - E_{res}\right] \quad (2)$$

Among them : *M*-human metabolic rate; *W*-acquired power; *H*-human body dry heat loss rate; C_{res}-human respiratory thermal convergence exchange law; E_C-the evaporative heat exchange rate of the human body at the heaviest heat sensing state; E_{res}-the human respiratory evaporation thermal conversion rate.

This theoretical formula (2) has been developed continuously and has been formulated by the ISO-7730 standard as follows:

$$PMV = \left(0.303 \cdot e^{-0.03M} + 0.028\right) \cdot \left\{ \begin{array}{l} (M - W) - 3.05 \times 10^{-3} \cdot [5733 - 6.99 \cdot (M - W) - p_a] \\ -0.42[(M - W) - 58.15] - 1.7 \times 10^{-5} \cdot M \cdot (5867 - p_a \\ -0.0014 \cdot M \cdot (34 - t_a) - 3.96 \times 10^{-8} \cdot f_{cl} \cdot \left[\begin{array}{l} (t_{cl} + 273)^4 - \\ (\vec{t}_r + 273)^4 \end{array} \right] \\ -f_{cl} \cdot h_c \cdot (t_{cl} - t_a) \end{array} \right\} \quad (3)$$

$$t_{cl} = 35.7 - 0.028 \cdot (M - W) - I_{cl} \cdot \left\{ \begin{array}{l} 3.96 \times 10^{-8} f_{cl} \times \left[\begin{array}{l} (t_{cl} + 273)^4 \\ -(\vec{t}_r + 273)^4 \end{array} \right] \\ + f_{cl} \cdot h_c \cdot (t_{cl} - t_a) \end{array} \right\} \quad (4)$$

$$h_{cl} = \begin{cases} 2.38 \cdot (t_{cl} - t_a)^{0.25} \; for \, 2.38 \cdot (t_{cl} - t_a)^{0.25} > 12.1\sqrt{V_{ar}} \\ 12.1\sqrt{V_{ar}} \; for \, 2.38 \cdot (t_{cl} - t_a)^{0.25} > 12.1\sqrt{V_{ar}} \end{cases} \quad (5)$$

$$f_{cl} = \begin{cases} 1.00 + 1.290 \cdot I_{cl}, \; for I_{cl} < 0.078 m^2 {}^\circ C / W \\ 1.05 + 0.645 \cdot I_{cl}, \; for I_{cl} < 0.078 m^2 {}^\circ C / W \end{cases} \quad (6)$$

Among these, *M*-human metabolic rate (W/m^2) ; *W*-external work (W/m^2) ; t_a-air temperature (° C) ; I_{cl} *(=clo)* -clothing thermal insulation val (*1clo=0.155m$^{2°}$C/M*) ; h_c -heat-transmission coefficient (W/m$^{2°}$C) ; t_{cl}-clothing surface temperature (° C) ; f_{cl} - ratio of the area covered by clothing to the area not covered;Var-relative air flow rate (m/s) ; P_a-partial vapour pressure (pa) ; t_r-average radiation temperature (°C) .

The *PMV* index is the average value of the estimated group of 7 levels of heat sensation based on human thermal balance (see table 2). When the heat generated in the body is equal to the heat dissipated into the environment, the person is in thermal equilibrium. In medium environments, the body's thermal adjustment system automatically adjusts the temperature of the skin and the amount of sweat to maintain the heat balance.

According to the ASHRAE comfort scale, the *PMV* value is divided into seven, from +3 to 3. When the calculated *PMV* value is zero, it indicates that the human body feels most comfortable in this state; +3 and -3, respectively, indicate that the person feels extremely hot and extremely cold in this condition.

Table 2: Seven levels of sensation measurements

PWV	Thermal sensation
+3	Hot
+2	Warm
+1	A little warmer
0	Moderate
-1	A little cool
-2	Cool
-3	Cold

2.2 PDD indicators

The *PMV* indicator is a subjective indicator that, in order to take into account individual differences, derives the *PPD* indicator, which is used to estimate the degree of human dissatisfaction with the environment [10]. When the PMV indicator is sought, the following relationship formula can be used to solve the PPD indicator:

$$PPD = 100 - 95 \cdot \exp \cdot \left[-\left(0.03353 \, PMV^4 + 0.2179 \, PMV^2\right)\right] \quad (7)$$

When the *PPD* indicator is between +5 and -5, the discomfort ratio for the general person is within 10%, so *PPD* values within this range can be identified as comfortable.

2.3 Correspondence between PDD indicators and PMV indicators

The *PPD* indicator is obtained based on the *PMV* indicator, and there is a correlation between it; the perpendicular axis is *PMV*, and the perverse axis is *PPD*, calculated as a percentage. When PMV is zero, the corresponding *PPD* index is 5%, indicating that only about 5% of people are likely to feel uncomfortable when the calculated *PMV* index is 0 when the body feels most comfortable. We can use this relationship to make a more objective assessment of thermal comfort.

This paper uses an experimental combination of CFD analyzers to obtain the six parameters needed to calculate the *PMV* value. Bringing the six into the procedure written by equations (2) to (7), the relationship between *PMV* indicators and *PPD* indicators can be obtained, and the thermal comfort of passengers in the vehicle can be analyzed using this relationship.

III. NUMERICAL SIMULATION OF AIR FLOW ORGANIZATION IN THE AIR CONDITIONING VEHICLE

This paper is mainly about solving the problem of human body thermal comfort in the environment, and this problem mainly lies in the adjustment of air conditioning. Ventilators are an indispensable part of air conditioning. When adjusting the temperature, the winding angle of the ventilators is also important. For this, we chose winding angles of 30 degrees, 45 degrees, and 60 degrees to discuss. In this process, we measure the frequency of fixed winding leaves.

Therefore, this paper uses Fluid to simulate the winding width of the fan leaf, leading to changes in the internal flow field of the car. Figure 3 is a numerical simulation of the process map. First, we need to establish the internal grid, then the boundary conditions, temperature, and humidity measured by the grid and the experiment measurement of the vehicle with the fluent to solve the temperature field and flow field in the vehicle, and finally, by comparing the experiment and the calculated temperature field to verify the process and predict *PMV* and *PPD*.

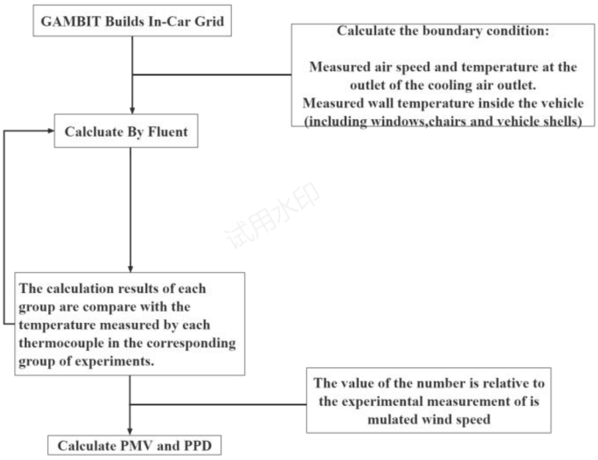


Fig.3: Fluent-Simulated Process Chart

3.1 Inside and outside of the vehicle

The software used by GAMBIT is the FLUENT preprocessor. GAMBIT can build a geometry (CAD), build a mesh, check the quality of the mesh, and set the boundary area. In the area of the grid, GAMPIT can create a structural and non-structural mesh. The type of mesh it provides is quadratic, five-faceted, hexadecimal, and so on.

3.2 Numerical methods

In Fluent, the main dominant equations sought to be solved are: continuous, dynamic, and energy equations [12]. In the mathematical model, in order to simplify the problem, Fluent uses the concept of the limited volume method to convert the dominant to the algebraic equation so that it can be resolved numerically. This limited volume approach exists for each control volume in the dominant form of a point, i.e., in a dispersed equation that holds the physical masses in the control volume. If φ represents an arbitrary physical mass, to disperse the dominance equation, it is first to represent in a point form φ the stable observation transmission of a controlling volume V as follows:

$$\int \rho\phi\vec{V}\cdot d\vec{A}=\int \Gamma_{\phi}\nabla\phi\cdot d\vec{A}+\int S_{\phi}d\vec{v} \qquad (8)$$

Among them are: $\vec{V}$ -velocity vector; $\vec{A}$ -vector-oriented; Γ_{ϕ} -φ dispersion coefficient; S_{ϕ} -source flow item per φ unit of volume; ρ -density.

The formula (13) can be applied to the control volume or grid in the computational field. In solving the problem of pressure-speed-field fusion, the SIMPLE algorithm is used to solve the problem. The SIMPLE algorithm [13] uses speed and pressure correction to force quality constancy and solve pressure fields.

3.3 Border conditions and convergence conditions

In terms of temperature setting, the boundary conditions of the non-stable temperature field and time change in the search engine are set to adjust the temperature of the cold air outlet measured by the experimental volume to the data of the change in time, and the corrected equation is written as a custom function hanging in FLUENT.

When the change in the stable temperature field in the car, the flow field, is to wait for the state of the car to stabilize, measure the temperature of the outlet of the cooling air, the window temperature, the interior temperature, and the seat temperature, and use the average value as the boundary conditions. In setting the wind speed of the cold air outlet, it is directly measured by measuring wind speed as the boundary condition. At the passenger's boundary conditions, the heat yield rate is 58/mw when the body is sitting, while the body temperature is set to

34.5 °C on the surface of the clothes. Table 5 provides the setting of all boundary conditions. Convergence conditions, with the residual value to make judgment procedure convergence.After the boundary conditions and convergence conditions are determined, the final output can be obtained using fluid for simulated calculations.

Fig.4: Boundary conditions set

Boundaries	Set
Cold air outlet	At the inlet (for a given amount of measured with speed and temperature)
Exhaust port	Flow at exit (free boundary condition)
Inside the hub	Vehicle surface (given measured temperature)
Chair	Vehicle surface (given measured temperature)
Passenger	Car surface (given the rate of heat generation and the body temperature measured while sitting)

The convergence criterion in this paper in the energy equation is based on 10^6, and all other physical masses are based on 10^3.

IV. AIR-CONDITIONING DESIGN

4.1 Car Air Conditioning Heat Load

The condition for the calculation of the heat load of the air conditioning is that all the heat transfer area of the car is 1.96 m^2 in the roof area and 5.42 m^2 on the side; all heat transfer parts are based on the thickness of the cross-section of the SUV model; the speed of the vehicle is set at $V=40$ km/h; and the compressor speed is based on 3.0 L of the Hyundai SUV engine [14].

The heat load of car air conditioning is mainly the heat load from new and leaked winds, the heat dissipation of the driver and passengers in the car, the heating transmission of the body structure and the outside, the thermal load of the electronic equipment and lighting lamps in the vehicle, the engine heat transmission, and so on.

4.1.1 Determination of conditions

Regarding the conditions in the vehicle, According to actual experimental data, the temperature of 24 to 26 °C is the optimal temperature that the human body feels in a hot summer, so the setting of the indoor temperature is: $t_1 = 25$ °C. When the relative humidity in the cabin is less than 30% or greater than 70%, the body will feel uncomfortable, but it will be more comfortable when it is in the range of approximately 45 to 60%.On the basis of human hygiene requirements, each person should have 16 to 33 m^3/h of new wind.Taking into account the possibility that the car may be parked regularly or the passenger switched the door, the air exchange volume is set here: $V = 55\ m^3/h$ (at 11 m^3/h per person).

Regarding the outside conditions of the car, this paper takes into account the internal and external environments commonly used by the hot and high temperatures of the summer and the car air conditioning system, as well as searching for the relevant information [15], so the outer boundary conditions of this car are determined as: sunlight intensity: $I_{level} = 0.98\ kw/m^2$; $I_{vertical} = 0.16\ kw/m^2$; $I_{dispersed} = 0.04\ kw/M^2$; ambient temperature: $t_2 = 40°C$; relative humidity: $\varphi=60\%$.

4.1.2 Determination of the hourly driving speed and speed of the compressor

The timing speed of the car and the compressor is defined as: timing velocity: $V=40km/h$; compressor belt wheel diameter: $d_{pressure}=120mm$; engine belt wheels: $d_{speed}=137.4mm$; tire rolling radius: $r=0.319\ mm$; gearbox main deceleration ratio: $i_o=3.978$; gearboxes 3 degrees reduction ration: $i_3=1.0$; gearbos 4 degrees deceleration ratio: $i_4=0.72$; engine/compressor drive ratio, $i=1.145$; compression engine rotation speed, $N_{pressure}=1516\ rpm$; compressor rotation rate, $N_{voltage}=1090\ rpm$; compressors average rotation: $N_{average}=1303\ rpm$; counter-engine rotation, $N_{output}=1324\ rpm$; and counter-generator rotation velocity, $N=952\ rpm$; engine output at 1140 rpm: $20KW$.

4.1.3 Establishment of thermal balance relations

The heat load of the car is composed of the various heat loads that enter the cabin. The approximation of the stable heat transfer is used in the following processes as the thermal balance ratio [7-16]:

$$Q_e = Q_1 + Q_2 + Q_3 + Q_4 + Q_5 + Q_6 + Q_7 \tag{9}$$

In the formula: Q_e: air-conditioned heat load; Q_1: heat load into the cabin through the car's roof, door, and other body-covering structures; Q_2: heat load in the cabinet through the engine cabin; Q_3: heat load through the floor into the car cabin; Q_4: heat load inside the car through the door window glass and windshield; Q_5: New air winds bring the heat load to the cabins; Q_6: Heat load of the motor and lighting lamps in the car; Q_7: heat load dispersed by the human body and the heat dissipation of other objects in the vehicle.

4.2 Determination of the cooling volume of the air-conditioning system

In the formula : $Q = \alpha_1 Q_e$ (10)

The α1-reserve coefficient can be picked from 1 to 1.2; the reserve factor is corrected. The value is 1.02. That is, at a speed of 40 km/h, the system cooling capacity should reach about 4611.8 W.

4.3 Determination of refrigerant circulation flow

The coolant cycle is the core part of a coolant system, and its basic function is to absorb and release heat through the phase change of the coolant (liquid to gas, gas to liquid), thereby achieving a cooling effect.

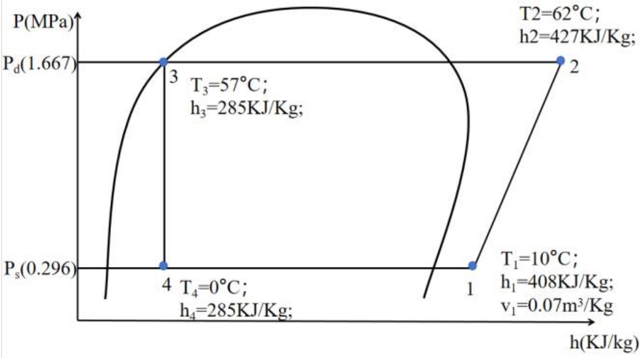


Figure 5: Working pressure chart of the air conditioning system

1 to 2 is the equilateral mercury compression process; 2 to 3 is the equilateral pressure condensation process; 3 to 4 represents the equilibrium merger flow process. 4 to 1 represents the equilibrium pressure evaporation process.

1 of these points indicates the point of inhalation of the compressor; 2 points indicate the exhaust point; P_d indicates condensation pressure; P_s indicates evaporative pressure; T_s indicates air temperature;T_d indicates the exhaust temperature;

Mass flow of refrigerant cycle: $m \approx 0.035\ kg/s$; volume flow of coolant cycle: $V = 2450\ ml/s$.

4.4 Calculation of compressor emissions

Required compressor emissions: $q_v = 136\ ml/r$;

the cooling volume of the compressors must be in accordance with the selected system; according to the performance curve of Dks117.the indicated efficiency of the compressor is: $\eta_i = 0.82$; the actual power consumption of the machine is: $N = 2.93\ KW$.after calculation, the power actually consumed by the compression machine is deducted by the power output of the engine. With 2.93/20 = 14.7%, the power consumption ratio is therefore permissible according to the compressor power prescription table and can be matched [17].

4.5 Calculation of condenser capacity

Condensed heat exchange capacity: $Q_{cool} = 5.26\ KW$; heat exchanger load ratio: $Q: Q_{cold} = 1: 1.14$.

To obtain accurately the weight of the heater in a small car. Many factors need to be taken into account, for example, local losses, which are divided into pressure and pipeline losses. Evaporator cooling volume Q_{vapor} and system cooling quantity Q_e should be consistent, so $Q_e = Q_{vapor}=4611.8W$.

4.6 Determination of ventilation capacity

Input temperature $t = 28°C$; input relative humidity $\Psi = 50\%$; input $h = 58.5KJ/kg$;

output temperature $T = 10°C$; output relative moisture $\Psi = 70\%$; output $h = 23.5KJ/kg$.

Ventilation wind capacity: $v \approx 474\ m^3/h$ Wind capacity has a crucial role in the evaporator. Therefore, the transmission of wind volume requires strict control.

V. RESULTS AND DISCUSSION

This paper first uses Fluent software for numerical simulation and then *PDD* and *PMV* for determining the leaf to optimally accommodate body heat comfort. Then design parameters such as the car air-conditioning cooling cycle and the transmission of wind volume to meet the requirements of human thermal comfort.

The first step is to determine the optimum latitude of the leaf, and this paper uses Fluent for a numerical simulation, and the results are determined by *PDD* and *PMV*. First, use Fluent to compile the internal flow field in the car. Then add the theoretical formula to obtain the values of the different latitudes of the sheet. Finally, according to the theory formula of *PMV* and *PDD*, add the data obtained from the simulation, thereby making a judgment of human comfort compared to Table 2. Based on the numeric simulation results, we find that when the sheets are 30 degrees wide, because the latitude is smaller, the passengers in the rear seat feel the higher wind volume and the lower temperature. When the latitudes are 60 degrees, because of the larger latitude, the wind is less easily blown to the back seat, resulting in a lower wind and a higher temperature perceived by the back passenger.

The second step is the setting of the air conditioning cooling parameters.The following data can be obtained by calculating parameters such as air conditioning cooling quantity and delivering wind capacity to achieve optimal thermal comfort for the human body. First of all, the conditions in the vehicle are set, and then the heat balance relationship, cooling cycle relationship, and cooling circulation flow are determined. Finally, the data is brought into the calculation of the determination value of each parameter, and the optimum parameter is obtained by comparison.

This is the result of the calculation. Data can be obtained from the thermal balance ratio formula, $Q_e=4521.4W$. Among them, $Q_1=867W$, $Q_2=159W$, $Q_3=189W$, $Q_4=1604.3W$, $Q_5=775.5W$, $Q_6=96W$, and $Q_7=830.6W$. According to the data analysis, the largest distribution of heat load is about 35% of windshield glass, followed by about 20% of the fence structure. Therefore, in order to reduce the heat load in the car, it should be based on improved body insulation and window glass material. With regard to the calculation of the cooling volume, the result is that when the speed of the vehicle reaches 40 km/h, the system cooling capacity should reach about 4611.8W.Taking into account the dirt from the outside as well as the local heat loss of the car. Therefore, the general heat exchanger load ratio on the car is 1: 1.5 to 1: 2, that is, the heat exchange capacity of the condenser is $Q_{cold}=6.9$ to 9.2 KW. Evaporator cooling volume Q_{vapor} and system cooling quantity Q_e should be consistent; $Q_e=Q_{vapor}=4611.8W$. As for the determination of the ventilation volume, because the air volume is too large if it is designed, it will cause costs and also cause unnecessary noise. An increase in the soundproofing will also generate increased costs, so it is difficult to arrange the fan layout. Another extreme aspect is that the humidity of the floor in the car cannot be averaged. Nor can stability be maintained if the air volume is too small. After the calculation of the ratio, the optimum output volume in this paper should be 474 m^3/h.

By the above calculations and parameters determined, this paper obtained the optimum width of leaf rolling is 45°, the best case of the transmission of wind volume should be 474 m^3/h, when the speed of the car reaches this paper, the system cooling volume should reach about 4611.8W, heat exchanger load ratio 1:1.5~1:2 about.

VI. CONCLUSIONS

This design uses Gambit software to calculate the speed field and temperature field values in the air-conditioned vehicle cabin and uses Fluent flow field calculation software to numerically simulate and analyze the flow field in the cabin. On the basis of the predecessor, a calculation model was proposed to evaluate the heat comfort of the human body in the car room under an uneven thermal comfort environment. By analyzing the temperature cloud chart in the car, speed vector chart, flow chart, etc., and after processing the numerical calculation of the display flow field, a comparative analysis and evaluation of human thermal comfort in the chamber of various operations was carried out, and the data for the optimum thermal comfort of the human body was obtained. This is important for improving the structure and design of the internal environment for the air conditioning system while using simulation software for data analysis to solve the high cost of the vehicle.

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