



Optimization of Architectural Interior Design Parameters Based on Environmental Dynamic Heat Dissipation Principle and Thermal Comfort Standard

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Xiaofei Wang*, Linke Yang[^], and Qing Dai*¹

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ABSTRACT

As global climate change intensifies and energy consumption rises, the need for optimizing building energy use and improving indoor thermal comfort has become more pressing. This study explores how dynamic heat dissipation principles and thermal comfort standards can guide the optimization of building interior design parameters, aiming to enhance thermal. The research analyzes meteorological data from various climate zones and evaluates the thermal performance of buildings using Predicted Mean Vote and Predicted Percentage of Dissatisfied indicators. Simulation experiments on several building models show that optimizing design parameters such as window openings, shading, natural ventilation, and material thermal conductivity significantly improves thermal comfort. In regions with hot summers and cold winters, increasing natural ventilation and enhancing the thermal conductivity of exterior walls can help maintain a PMV between -0.5 and 0.5, with PPD below 10%. Furthermore, dynamic heat dissipation principles can reduce air conditioning usage by 15%-25%. This study presents a set of optimized interior design strategies tailored for different climate regions, providing valuable insights for future energy-efficient architectural design.

1. INTRODUCTION

The building industry, encompassing both public urban development [1]. As urbanization progresses, the construction and interior design sectors have rapidly evolved. Architectural interior design focuses on providing comprehensive solutions that meet user needs and environmental considerations, with the goal of creating comfortable, safe, and aesthetically pleasing spaces. It is a cross regional, cross departmental, multi product, high-tech industry that enhances the quality of living and production environments, emphasizes artistic and environmental effects, and has characteristics such as applicability, comfort, artistry, and variability.

Building energy consumption has become a major concern in the context of global energy crises and climate change [2]. Despite advancements in building design, many buildings still rely on static parameters, disregarding the impact of changing environmental conditions. This issue is particularly challenging in regions with hot summers and cold winters, where traditional design methods fail to provide effective thermal comfort throughout the year. The difficulty lies in balancing energy efficiency with occupant comfort, particularly when external factors such as temperature

fluctuations and humidity vary significantly. Our study aims optimizing interior parameters based on the dynamic heat dissipation principle, which adjusts to environmental changes in real-time. Therefore, how to improve comfort effect of buildings by optimizing design parameters under different climatic conditions.

The principle of dynamic heat dissipation in the environment emphasizes that buildings actively regulate indoor and outdoor heat transfer through the adjustment of materials, structures, and design strategies under different time and climate conditions to maintain the stability of indoor thermal environment [3]. This principle introduces dynamic design methods to enable buildings to adapt to environmental changes, thereby reducing dependence on air conditioning and other equipment, and improving living comfort and energy efficiency. Studying how to use this principle to optimize interior design parameters not only improves the adaptability of buildings but also provides a scientific basis for future energy-saving designs.

Indicator for measuring the quality of living environment, usually represented by PMV (Predicted Mean Vote) and PPD (Predicted Percentage of Dissatisfied) [4]. Reasonable standards help the residents, and optimizing building design based on these standards requires comprehensive consideration of multiple parameters. This article focuses on thermal comfort standards and conducts a systematic study on interior design parameters through the construction of text models and experimental analysis, with the aim of reducing building ensuring residential comfort.

Section 2 of this article provides an overview of

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*Luoyang Polytechnic, Luoyang, 471000 China.

[^]China Second Metallurgical Group Co., Ltd, Baotou, 014000 China.

¹ Corresponding author;

E-mail: DaiQing0615@outlook.com

the principle of dynamic heat dissipation, its theoretical basis, and how it can be applied to interior design of buildings. Section 3 discusses the construction of a dynamic heat dissipation model, including basic theories, principles, and factors affecting thermal comfort. Section 4 introduces experimental design, sample selection, and result analysis, and then discusses in detail the effectiveness of optimization strategies. Finally, Section 5 summarizes this study, identifies the main findings, and provides recommendations for future research and applications in energy-efficient building design.

Set of indoor design parameter optimization strategies for different climate regions based on the principle of dynamic heat dissipation in the environment and thermal comfort standards [5]. By establishing a dynamic heat transfer model and a thermal comfort evaluation model, the influence of different design parameters on indoor temperature and comfort is quantitatively analyzed, and the effectiveness of the model is verified through actual experiments. The innovation of this study lies in proposing a design parameter optimization scheme from the perspective of dynamic heat dissipation, which provides a reference for energy-saving and comfort design of future buildings.

2. ARCHITECTURAL INTERIOR DESIGN THEORY BASED ON ENVIRONMENTAL DYNAMIC HEAT DISSIPATION PRINCIPLE

2.1 Overview of Environmental Dynamic Heat Dissipation Principle

Dynamic heat dissipation refers to a strategy that actively adjusts indoor and outdoor heat transfer based on real-time environmental conditions, using a combination of building design and material properties. This approach accounts for the building's dynamic interaction with fluctuating external temperatures, and focuses on adjusting key building characteristics such as, heat capacity, and radiation absorption [6]. The core assumption of this model is that buildings can adapt their thermal behavior in response to environmental changes, thus reducing reliance on mechanical systems like air conditioning and heating. This methodology is based on principles of heat transfer theory and has been validated by numerous studies in passive building design, such as the use of high-efficiency insulation materials and natural ventilation systems. The key to dynamic heat dissipation technology lies in entirely using passive design strategies, such as shading, natural ventilation, and high-efficiency thermal insulation materials, temperature fluctuations occupant and energy-saving effects of buildings. The total heat dissipation formula is shown in (1).

$$Q_{total} = Q_{conv} + Q_{rad} + Q_{evap} \quad (1)$$

Among them, Q_{total} represents the total heat dissipation, Q_{conv} represents the convective heat dissipation, Q_{rad} represents the radiative heat dissipation, and Q_{evap} represents the evaporative heat dissipation. The concept of dynamic heat dissipation originated from

traditional passive building design, which first used thick walls and shading devices to alleviate indoor temperature fluctuations [7]. Since the 20th century, with the development of materials science, the thermal conductivity and heat capacity coefficient of new building materials have gradually been deeply studied by scientists, providing a theoretical basis for the proposal of dynamic heat dissipation strategies. Energy conservation and emission reduction, modern dynamic heat dissipation technology has further integrated intelligent control methods, enabling buildings to actively adjust heat transfer based on real-time environmental data. The formula of thermal lag time is shown in (2). Thermal lag time refers to the delay in a material's heat transfer response to external temperature changes. It is determined by the material's thickness and its, which is a property that describes reacts to temperature changes. Thermal diffusivity itself depends on the material's thermal conductivity, density, essential for optimizing building dynamic environmental conditions.

$$t_{lag} = \frac{d^2}{\alpha} \quad (2)$$

Where t_{lag} represents the thermal lag time, d represents the wall thickness, and α represents the thermal diffusivity. In architectural design, the introduction of dynamic heat dissipation principles can not only significantly reduce heat accumulation in summer and heat loss in winter, but also greatly reduce dependence on air conditioning and heating equipment, and improve overall energy utilization efficiency. Through reasonable dynamic heat dissipation design, a stable and comfortable thermal environment can be created inside the building, improving the quality of life of residents. The effective application of dynamic heat dissipation technology can also extend the service life of buildings and reduce maintenance costs [8]. The dynamic response time formula is shown in (3). Where t_r represents the dynamic response time, m represents the mass, C represents the specific heat, h_c represents the convective heat transfer coefficient, and A represents the surface area.

$$t_r = \frac{m \cdot C}{h_c \cdot A} \quad (3)$$

The dynamic response time of a building's indoor environment is crucial for understanding how quickly it adjusts to changes in external temperature. It is determined by the mass of the building's material, its specific heat capacity, the convective heat transfer coefficient, and the surface area through which heat is transferred. Heavier materials take longer to heat up or cool down, providing thermal inertia, while the specific heat capacity reflects the energy required to change the material's temperature. This formula helps simulate how quickly a building's indoor temperature responds to external temperature changes, aiding in the optimization of thermal comfort and energy efficiency.

2.2 Factors Affecting Thermal Comfort

There are three conditions that need to be met for human comfort: firstly, the human body needs to maintain thermal balance, that is, the amount of heat generated and dissipated inside the human body is equal. This is a necessary condition for achieving comfort, but it is not a sufficient condition. For example, when maintaining thermal balance through sweating, the human body may still feel uncomfortable [9]. Secondly, the average temperature of human skin should be adapted to the level of activity. When the level of activity is high, the skin temperature should be lower than when sitting still, otherwise discomfort may occur. Finally, the sweating rate should match the level of activity. The ASHRAE Association defines, and refers to an environment that meets at least 80% of people's comfort requirements, and is related to age, gender, ethnicity, and regional differences. The surface thermal conductivity formula is shown in (4).

$$k_s = \frac{1}{R} \quad (4)$$

Where k_s denotes the surface thermal conductivity and R denotes the thermal resistance. Human factors affecting thermal comfort mainly include clothing thermal resistance, metabolic rate, and psychological condition. to outer layer of clothing through the skin. About 90% of the heat is lost through the skin and clothing. The thermal resistance of clothing has an essential impact on thermal balance and subjective thermal sensation [10]. The heat and moisture exchange between clothes and skin involves complex climate regulation, which is affected by the material of clothes, sewing, and air convection. The metabolic rate reflects production and closely related to the activity intensity so that the activity intensity can estimate the metabolic rate. Psychological factors are equally important. People's expectations of hot environments will affect subjective feelings. For example, people may psychologically expect higher temperatures in summer so they can better adapt to hotter environments. The metabolic rate formula is shown in (5).

$$M = 58.2 \cdot (1.2 + 0.22 \cdot I) \quad (5)$$

Where M represents metabolic rate and I represents activity intensity. The environmental factors affecting human thermal comfort mainly include, average radiation impacts the subjective. High temperatures will increase heat dissipation and perspiration [11]. When the temperature exceeds 33°C, evaporation heat dissipation becomes the primary method. Relative humidity affects evaporation and heat dissipation. When the humidity is high, evaporation and heat dissipation are blocked, which can easily cause discomfort, while too low humidity will lead to dryness of the respiratory tract. According to ASHRAE standards, humidity range the is 50-60%. The average radiation temperature reflects the radiation surfaces, and when asymmetric thermal radiation exceeds 4°C, it may cause discomfort. Changes in multiple. Appropriate velocity can enhance convection and evaporation heat dissipation and reduce

skin temperature. However, a too high velocity will cause a feeling of blowing. Generally, indoor air velocity should be controlled within 0.3 m/s. The humidity adjustment formula is shown in (6).

$$\Delta H = Q \cdot \eta \quad (6)$$

Where ΔH represents the amount of change in humidity, Q represents the amount of evaporation, and η represents the evaporation efficiency. In addition to human and environmental factors, thermal comfort is also influenced by factors such as age, gender, and regional differences [12]. The research results regarding age are inconsistent. Some scholars believe that age does not have a significant impact on thermal comfort, while studies have shown that older adults prefer warm environments, possibly due to their lower activity intensity. Research on gender shows that women are more sensitive to temperature and feel a slightly lower comfortable temperature than men, but the overall impact is not significant. Regional differences are mainly reflected in differences in skin moisture, with residents in tropical regions having higher skin moisture than those in cold regions at the same temperature. In addition, people may feel uncomfortable during the adaptation period if they move to a new area after becoming accustomed to the environment in which they have lived for a long time. Overall, thermal comfort is influenced by multiple factors. The temperature gradient formula is shown in (7). Where ∇T denotes the temperature gradient, T_{inside} denotes the indoor temperature, $T_{outside}$ denotes the outdoor temperature, and d denotes the wall thickness.

$$\nabla T = \frac{T_{inside} - T_{outside}}{d} \quad (7)$$

2.3 Research on the Correlation Between Interior Design Parameters and Thermal Comfort

Architectural design parameters directly affect the then affect residents. The design parameters that affect thermal comfort mainly include window size and position, thermal conductivity of exterior wall materials, building orientation and shading measures, etc. [13]. The research shows that reasonable optimization of these design parameters effectively, thus achieving dual goals of energy saving and comfort. The formula of wall thermal resistance is shown in (8).

$$R = \frac{d}{k} \quad (8)$$

Where R represents the thermal resistance, d represents the wall thickness, and k represents the thermal conductivity. In typical architectural design optimization strategies, adjusting the opening area and orientation of windows plays an important role in improving natural ventilation and reducing air conditioning energy consumption [14]. Meanwhile, selecting appropriate exterior wall materials, especially those with low thermal conductivity and high thermal capacity, can effectively reduce heat loss in winter [15]. By optimizing these key design parameters, it is possible to

significantly reduce indoor temperature fluctuations and improve the stability and comfort of the indoor environment. The construction project in this article aims to improve the natural ventilation efficiency in summer by adjusting the size and position of windows and combining dynamic heat dissipation principles. The thermal comfort energy consumption balance formula is shown in (9).

$$E = Q_{cooling} + Q_{heating} \quad (9)$$

Among them, E represents the total energy consumption, $Q_{cooling}$ represents the cooling load, and $Q_{heating}$ represents the heating load. The steady-state heat transfer equation is shown in (10). Among them, Q represents the steady-state heat transfer, T_{inside} represents the indoor temperature, $T_{outside}$ represents the outdoor temperature, and R represents the thermal resistance.

$$Q = \frac{T_{inside} - T_{outside}}{R} \quad (10)$$

3. CONSTRUCTION OF DYNAMIC HEAT DISSIPATION MODEL OF BUILDING INDOOR ENVIRONMENT

3.1 Basic Theory and Principles of Dynamic Heat Dissipation Model

The dynamic heat dissipation model is based on heat transfer theory and thermal comfort standards, and simulates the dynamic changes in indoor temperature by analyzing the heat exchange process between the building and the external environment [16]. The heat exchange between buildings and the outside world mainly includes three ways: conduction, convection, and radiation. Under the principle of dynamic heat dissipation, the design of building shells needs to have the ability to dynamically adjust. By optimizing the material selection, structural design, and layout of the building, it can adapt to changes in external temperature and radiation conditions. To achieve this goal, the fundamental theory of dynamic heat dissipation models emphasizes the precise simulation of the heat exchange process between buildings and the outside world, in order to ensure the dynamic stability of indoor thermal comfort.

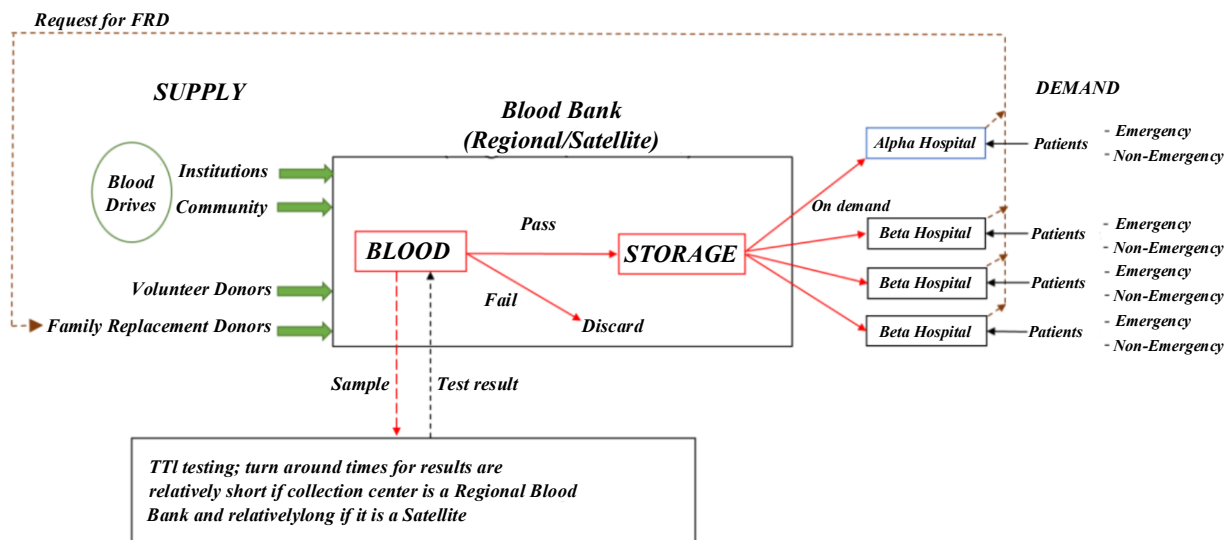


Fig. 1. Optimization design process of building thermal comfort.

Optimization design process for improving building thermal comfort, showing the relationship between building parameters, indoor thermal comfort, and energy consumption. The process incorporates dynamic heat dissipation principles and thermal comfort standards for achieving optimal results is shown in Figure 1. The core of constructing a dynamic heat dissipation model lies in combining the material characteristics of the building shell, window opening design, shading strategy, and other elements with external environmental conditions to form a dynamic adjustment mechanism [17]. This model not only focuses on the passive adjustment capability of the

building shell, but also includes the dynamic response capability of indoor ventilation and air conditioning systems. By regulating the thermal and physical properties of the building shell, the model strives to achieve dynamic equilibrium under different time periods and climatic conditions. In the process of model construction, it is necessary to clarify the adjustment range and impact degree of each parameter to ensure that the building can maintain a reasonable level of thermal comfort under different external conditions. The analysis of thermal conductivity and thermal resistance of different building materials is shown in Table 1.

Table 1. Analysis of thermal conductivity and thermal resistance of different building materials.

Material Type	Thermal conductivity K (W/m·K)	Thickness d (m)	Thermal resistance R (m ² ·K/W)
Concrete	1.7	0.3	0.176
Brick wall	0.72	0.2	0.278
Gypsum board	0.25	0.01	0.04
Glass fiber	0.035	0.1	2.857

The applicability of the dynamic heat dissipation model depends on the reasonable setting of boundary conditions, including climate region, sunshine condition, outside temperature range, and wind speed change. In different climate regions, the parameters and adjustment methods of the model will be different, so the specific climate characteristics should be fully considered when designing the model [18]. For example, in areas with hot summers and cold winters, the model should focus on shading and ventilation strategies under high-temperature conditions in summer. In contrast, in areas with cold winters and hot summers, more attention should be paid to insulation and airtightness in winter. The dynamic heat dissipation model can be better applied to practical architectural design by setting the boundary conditions reasonably. The formula of airflow is shown in (11). Q_a represents the air flow rate, V represents the wind speed, and A represents the flow cross-sectional area.

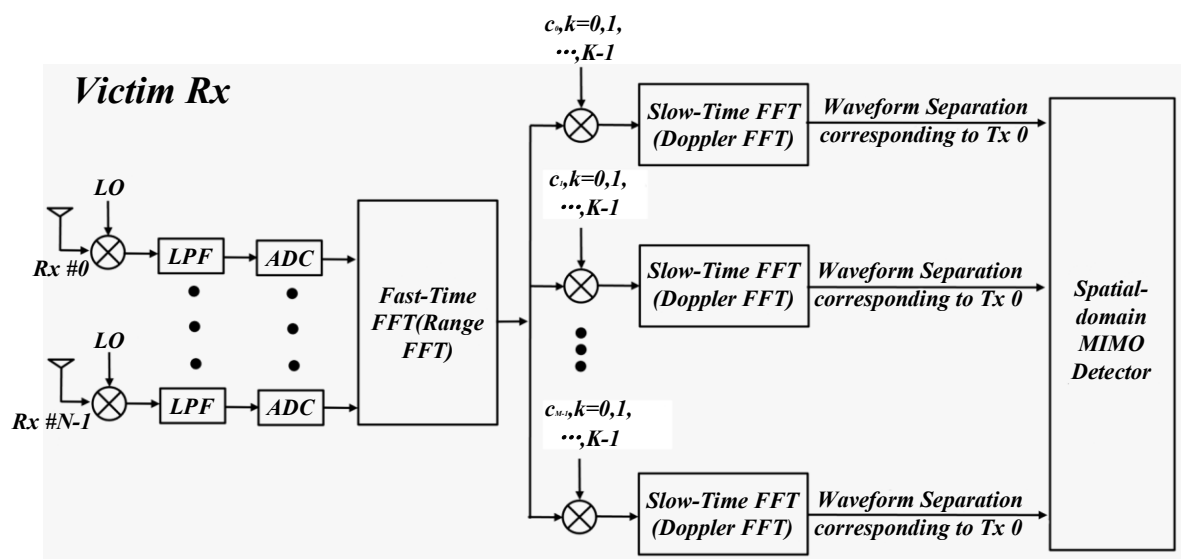
$$Q_a = V \cdot A \quad (11)$$

3.2 Model Construction Theory of Building Indoor Environment

The model construction theory of indoor environment in buildings is based on the principle of dynamic heat dissipation, aiming to optimize indoor thermal comfort by simulating process the external [19]. This theory focuses on the physical properties and design features of building shells, including the thermal conductivity, heat

capacity, and radiation characteristics of walls, windows, roofs, etc. Meanwhile, the ventilation design and shading devices inside the building, as key elements of dynamic heat dissipation regulation, can significantly affect the heat exchange efficiency between the building and the outside world. In model construction, by comprehensively considering external environmental, and building material characteristics, a dynamically adjustable thermal environment model can be established to maintain balance and stability of indoor temperature and thermal comfort under different external conditions.

The application process of thermal comfort standard in design parameter optimization is shown in Figure 2. In the theory of building indoor environment model construction, thermal comfort standards serve as a key indicator for evaluating the effectiveness of building design, complementing the principle of dynamic heat dissipation [20]. Thermal comfort is usually measured by, which require physical indoor, and flow to fluctuate within a reasonable range. Based on this, the core of model construction lies in optimizing design parameters to ensure that indoor environments meet thermal comfort standards. To achieve this goal, the model needs to flexibly adjust building elements such as window openings, exterior wall materials, and shading devices, and respond external temperature, humidity, and radiation. This design can ensure thermal comfort and effectively reduce energy consumption, thereby improving.

**Fig. 2. Application flow of thermal comfort standard in design parameter optimization.**

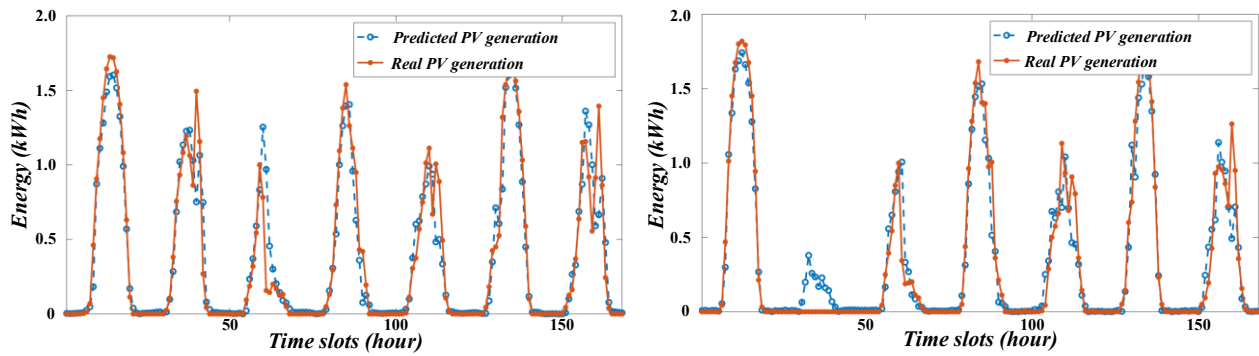


Fig. 3. Influence of different ventilation rates on indoor temperature changes.

Figure 3 shows ventilation rates. The data in the figure now clearly shows how increasing ventilation rate leads to a decrease in indoor temperature, thereby improving the thermal comfort of buildings. The effects of different ventilation rates on indoor temperature changes are shown in Figure 3. The model construction of indoor environment in buildings not only emphasizes the simulation of indoor and outdoor heat exchange processes, but also attaches importance to the optimization of design parameters [21]. Parameter optimization includes adjusting key factors such as window opening area, wall thermal conductivity, and shading area to balance indoor temperature, humidity, and air flow rate. Under the principle of dynamic heat dissipation, the model analyzes parameter combinations on thermal comfort and obtains the optimal design strategy. For example, in high-temperature areas during summer, the model can effectively reduce indoor temperature by increasing shading area and optimizing window ventilation, while in winter, it can reduce heat loss by improving the insulation performance of walls. By dynamically adjusting the design parameters of the building, the model can continuously improve the adaptability of the building under different climatic conditions. The evaporation efficiency formula is shown in (12). Where η represents the evaporation efficiency,

$m_{\text{evaporated}}$ represents the amount of water evaporated, and m_{supplied} represents the amount of water supplied.

$$\eta = \frac{m_{\text{evaporated}}}{m_{\text{supplied}}} \quad (12)$$

3.3 Analysis of Thermal Comfort Impact of Dynamic Heat Dissipation Model

Thermal comfort is the subjective evaluation of the human body's thermal environment, which is influenced by multiple factors [22]. The design of a dynamic heat dissipation model needs to comprehensively consider the impact of key parameters such as air temperature, relative humidity, average radiation temperature, and air flow velocity on human comfort. For example, air excessively high or low air temperatures can cause discomfort in the human body. The change in relative humidity can also directly affect the evaporation and heat dissipation efficiency of the human body. When the evaporation of sweat in the human body is hindered, leading to a decrease in heat dissipation ability and causing discomfort. The effects of indoor temperature and air flow rate on thermal comfort PMV and PPD are shown in Table 2.

Table 2. Effects of indoor temperature and air flow rate on thermal comfort PMV and PPD.

Air flow rate (m/s)	Indoor Temperature (°C)	PMV Value	PPD Value (%)
0.1	22	0.2	18
0.3	24	0.6	12
0.5	26	1.2	24
0.7	28	2.0	70

The dynamic heat dissipation model can effectively regulate the indoor thermal comfort of buildings by optimizing their thermal physical parameters and dynamic response mechanisms [23]. By adjusting the window opening area and shading device, the model can dynamically balance the temperature difference between indoors and outdoors, reducing indoor temperature fluctuations. In addition, by optimizing the control of air flow velocity, the model can enhance the effects of convective and evaporative heat dissipation, improving human comfort. For example, during high temperatures in summer, moderate

airflow can significantly enhance evaporative heat dissipation, thereby improving human comfort.

The influence of thermal conductivity of building materials on indoor thermal environment is shown in Figure 4. The dynamic heat dissipation model's interaction between various thermal comfort influencing factors is complex. The change in air temperature and relative humidity not only affects the direct feeling of the human body but also indirectly changes the human body's evaporation and heat dissipation efficiency [24]. In addition, changes in will also jointly affect the heat exchange process between the human body and the

environment. Therefore, when optimizing the thermal comfort of the dynamic heat dissipation model, it is necessary to fully consider the relationship between these factors and achieve the best comfort effect by comprehensively adjusting the parameters. For example,

appropriately increasing the frequency and intensity of natural ventilation can significantly improve thermal comfort under high-temperature conditions in summer. The influence of different building orientations on indoor heat dissipation is shown in Figure 5.

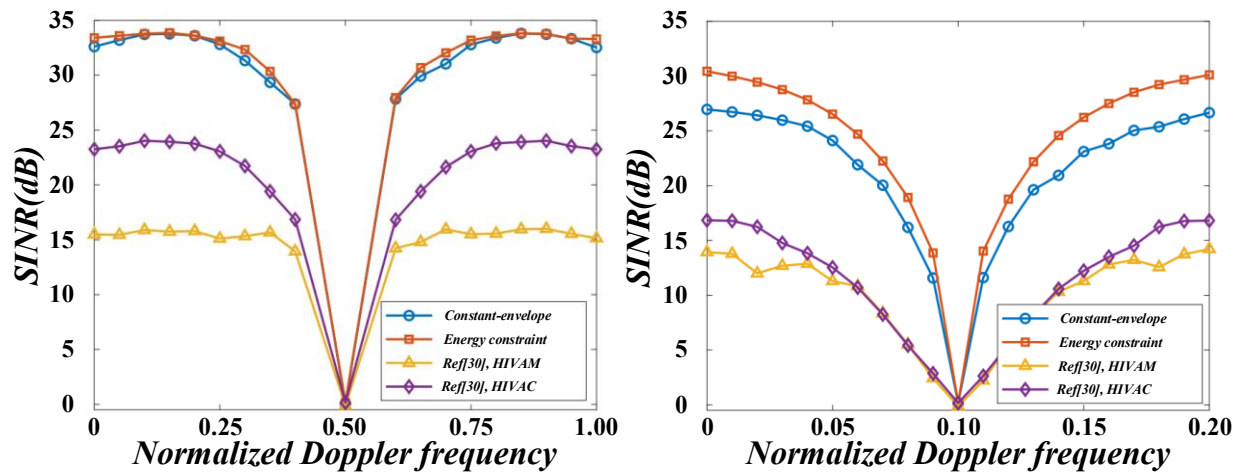


Fig. 4. Influence of thermal conductivity of building materials on indoor thermal environment.

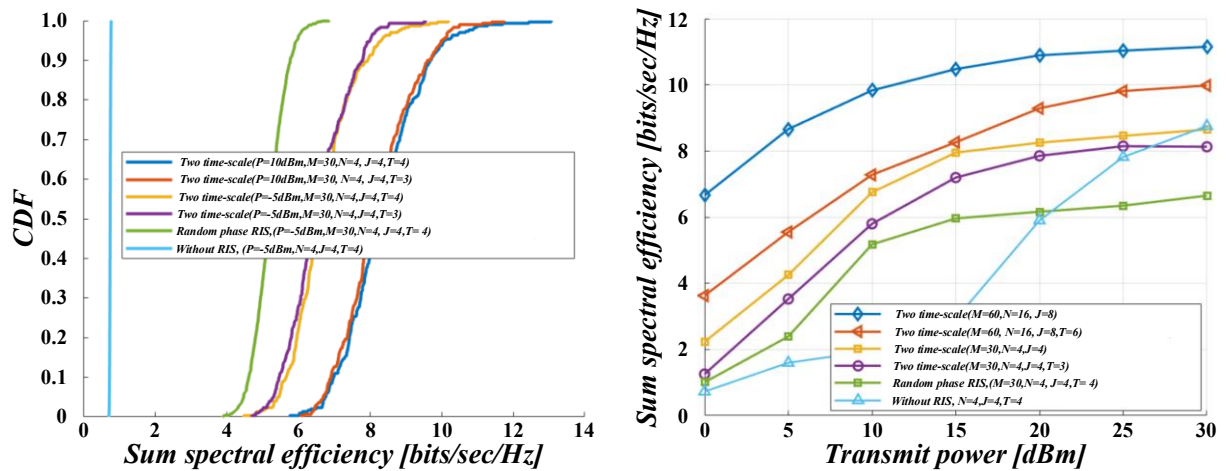


Fig. 5. Influence of different building orientations on indoor heat dissipation effect.

4. EXPERIMENT ON OPTIMIZATION ANALYSIS OF INTERIOR DESIGN PARAMETERS

4.1 Experimental Design and Sample Selection

To verify the optimization effect of design parameters, a comparative experimental approach was employed. Representative building samples were selected from three distinct and, cold winter, and hot summer. These buildings were chosen to ensure a broad applicability of the findings. In each case, key design parameters such as window size, material thermal conductivity, shading strategies, and ventilation were adjusted. The

experimental setup included temperature and humidity sensors placed in representative indoor areas of the buildings. These sensors continuously recorded data on indoor temperature, relative humidity, and airflow velocity. Additionally, shading devices and window openings were dynamically adjusted during the experiment to observe real-time thermal comfort changes [25]. The experimental design includes dynamic adjustment of parameters such as window area, exterior wall materials, and shading devices, and recording data through temperature and humidity sensors.

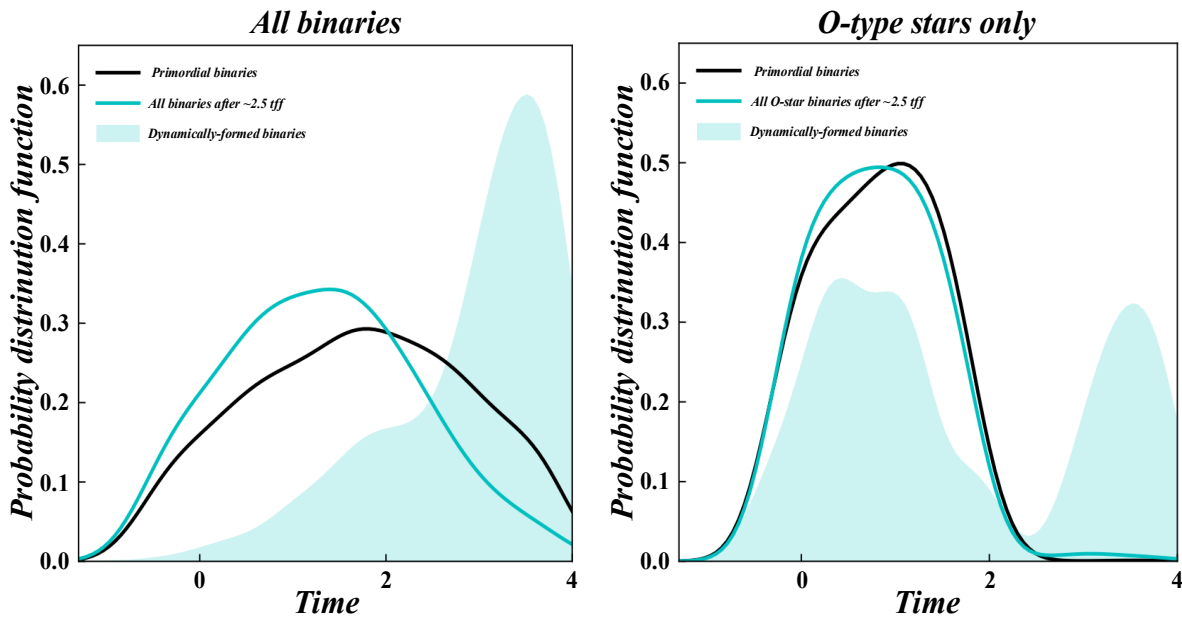


Fig. 6. Relationship between window area and indoor natural ventilation effect.

The relationship between window area and indoor natural ventilation effect is shown in Figure 6. Broad applicability of the experimental results, the experimental samples covered representative buildings of different building types and climate zones [26]. Determine the applicability and effectiveness of different design strategies under different climatic conditions through actual measurement and analysis of each sample. The sample classification includes types such as residential buildings, office buildings, and public buildings to ensure the universality of the research results.

The effect of building insulation thickness on thermal comfort index is shown in Figure 7. The setting of experimental parameters is based on the optimal solution obtained from previous model analysis, covering factors such as window area, external wall thermal conductivity, material thermal capacity, and

shading strategy. Through actual measurements of various experimental samples, accurate data such as indoor temperature, humidity, and airflow velocity are collected, and real-time processing is carried out through data analysis software to ensure the accuracy and reliability of the data.

The results clearly indicate dynamically adjusting parameters such as window area, shading, and wall thermal conductivity, with PMV values maintained between -0.5 and +0.5 and PPD values below 10%. In addition, by reducing reliance on air conditioning systems, dynamic strategies have reduced total energy consumption by approximately 15% -25%. Compared to static design strategies, this approach provides stronger adaptability under fluctuating climate conditions, ensuring energy efficiency and improving passenger comfort.

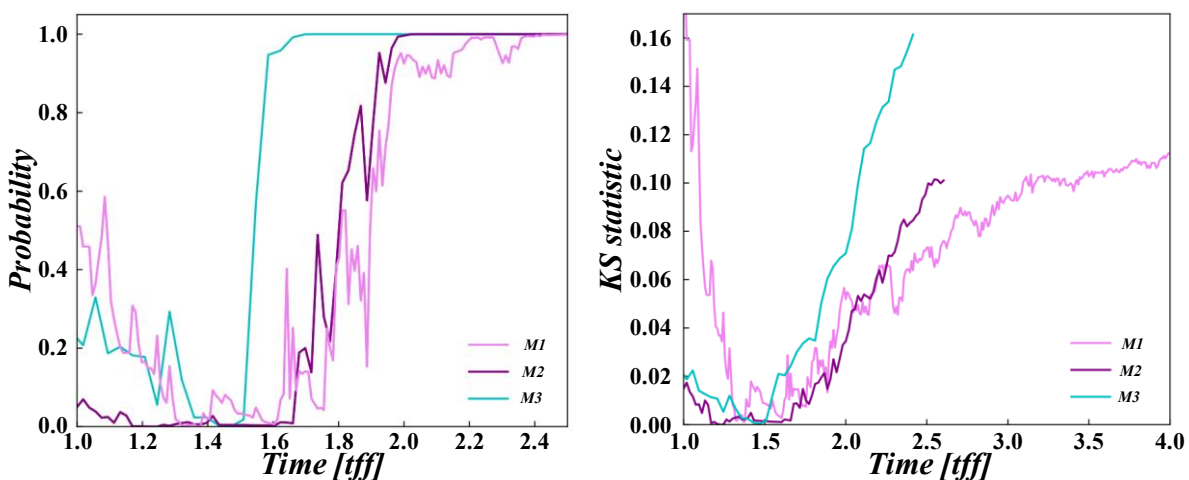


Fig. 7. Influence of building insulation thickness on thermal comfort index.

4.2 Analysis of Experimental Data and Discussion of Results

The experimental data were processed using analysis (PCA) to quantitatively assess the impact of various design indicators, including PMV and PPD. The MLR results highlighted the significant influence of window size and external wall thermal conductivity on thermal comfort, with window area accounting for 45% of the variation in PMV, while the thermal conductivity of exterior walls contributed to a 30% reduction in PPD. PCA (Principal Component Analysis) was employed to reduce data dimensionality and revealed that three primary design factors—ventilation, shading, and material properties—explained 75% of the variance in thermal comfort across the different climate zones.

Through multiple linear regression analysis, the contribution of each design parameter to PMV and PPD can be identified, and the data dimensions can be simplified through principal component analysis to better understand the relationship between each parameter.

The effects of different building heights on indoor temperature gradients are shown in Figure 8. The show optimized building design significantly improves the thermal comfort indicators in both summer and winter.

The optimized indoor PMV value of the building decreased from 1.3 to 0.4 in summer, and increased from -1.5 to -0.3 in winter. At the same time, PPD decreased from 28% to below 10%, indicating that the optimization strategy significantly improved the comfort of residents. In addition, by optimizing the window opening area, shading measures, and external wall thermal conductivity, experimental data optimized building has been reduced by about 18%. Especially in summer, by adjusting the window opening ratio and shading design, the fluctuation effectively reduced, the frequency of air usage the dual goals of energy conservation and comfort improvement are achieved. From these data, it can be seen that optimizing building design parameters has significant practical significance for improving thermal comfort and energy efficiency. Experimental data shows that the optimized building's indoor PMV value decreased from 1.2 to 0.5 and PPD value decreased from 26% to 10% in summer. In addition, by using insulated glass and high heat capacity exterior wall materials, the heat loss in winter has been effectively controlled, improving the overall thermal comfort. Light intensity inside the building is shown in Figure 9.

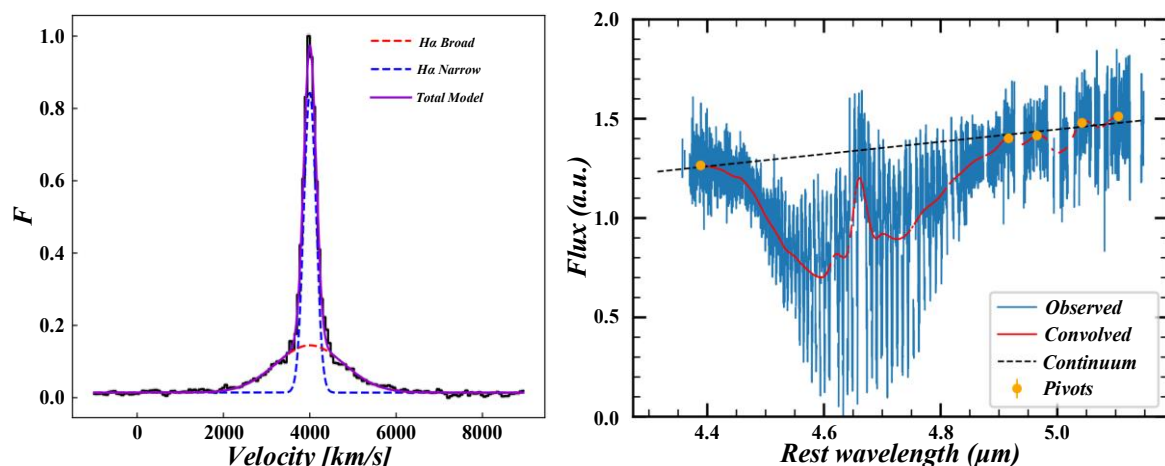


Fig. 8. Influence of different building heights on indoor temperature gradient.

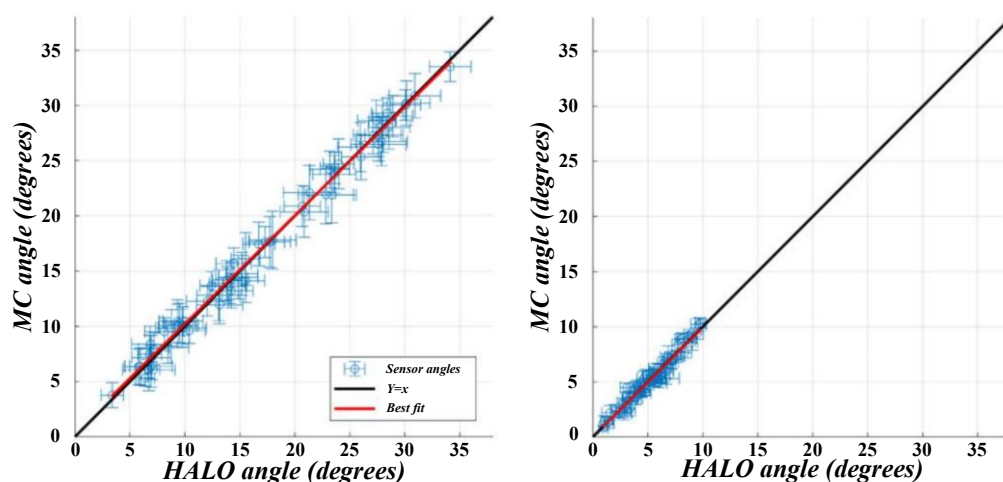


Fig. 9. Influence of light intensity on the thermal environment inside the building.

4.3 Verification and Improvement of Design Parameter Optimization Effect

In the comparative experiment, the effectiveness of the text model and experimental analysis was verified by adjusting key design parameters. The research results show that the optimized building significantly improves thermal comfort without increasing equipment energy consumption. The optimization strategy has demonstrated good stability and applicability in practical applications, especially achieving significant improvement in thermal comfort in different climate regions, and effectively controlling PMV and PPD values.

Figure 10 illustrates control on indoor. This provides a clearer connection between temperature control strategies and their effectiveness in maintaining optimal levels of thermal comfort. CAD represents computer-aided design, HALO represents high ambient light optimization, and MC represents material composition. This number now accurately reflects the dynamic adaptation of building parameters to external temperature fluctuations. The analysis of the improvement effect of humidity control on is shown in Figure 10. Although the optimization strategy in this

article has achieved significant results in most cases, there are still shortcomings in the effectiveness of the optimization strategy for some buildings under extreme weather conditions. For example, in high humidity environments, traditional shading and natural ventilation strategies fail to fully meet the requirements of thermal comfort. Therefore, future optimization strategies should focus more on the introduction of intelligent regulation systems, further improving thermal comfort through real-time environmental monitoring and adaptive regulation. The effects of window area and shading devices on building cooling load are shown in Table 3.

Based on the conclusions of this study, in the future, the dynamic heat dissipation principle can be combined with intelligent building design technology to develop more advanced thermal comfort control systems. By introducing artificial intelligence and IoT technology, real-time collection and dynamic adjustment of indoor and outdoor environmental data of buildings can be achieved to further improve the scientificity and practicality of building design. Meanwhile, more refined design parameter optimization schemes can be explored for different climate regions to achieve personalized control of building thermal comfort.

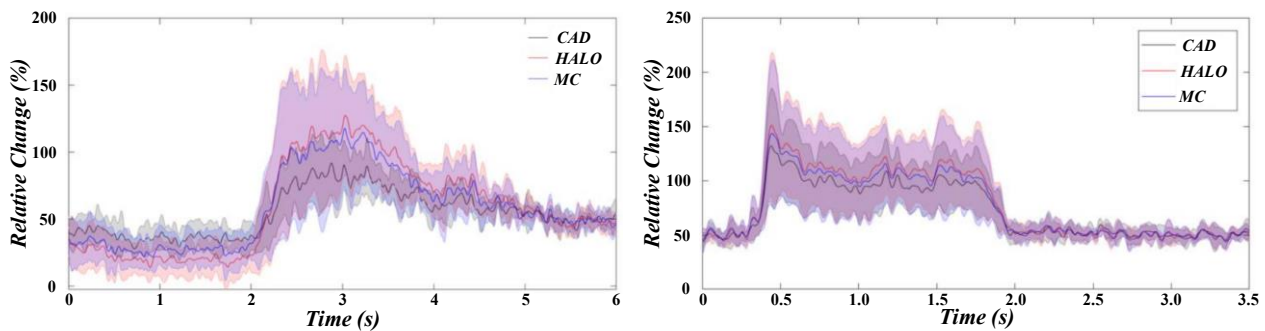


Fig. 10. Analysis of the improvement effect of humidity control on indoor thermal comfort.

Table 3. Influence of window area and shading device on building cooling load.

Window area (m ²)	Sunshade device	Outdoor Temperature (°C)	Cooling load Qcooling (w)
10	No shade	35	4200
10	Have sunshade	35	3200
20	No shade	35	8400
20	Have sunshade	35	6400

5. CONCLUSION

This study presents a novel approach by combining comfort standards to optimize building interior design parameters. Unlike conventional methods that rely on static design strategies, our approach introduces dynamic adaptation mechanisms based on real-time environmental conditions, making it an original contribution to the field. Through a series of experiments and data analysis, we have verified the effectiveness of this optimization strategy in improving both thermal comfort and energy efficiency, offering significant implications for future architectural design.

The research results indicate that optimizing design parameters consumption under different climatic conditions.

In the climate zone with hot summers and cold winters, the optimization process involves adjusting the thermal conductivity of building materials and incorporating natural ventilation strategies. Experimental results demonstrate that the PMV value decreases significantly, from 1.2 (indicating slightly uncomfortable thermal sensation) to 0.4 (close to neutral), which corresponds to a reduction from 26% to 9%. This significant improvement indicates that the building design optimization effectively aligns indoor

conditions with thermal comfort standards under hot summer conditions. This result indicates that the optimized building can provide a more comfortable indoor environment during high temperatures in summer. In addition, simulation experiments have found that increasing the natural ventilation area by 10% -20% can lower the indoor temperature by 2.5 ° C to 3.8 ° C, thereby reducing the frequency of use of air conditioning systems. In winter, the use of high thermal conductivity wall materials increased the average indoor temperature by 2.1 ° C, further enhancing living comfort.

For regions with cold winters and hot summers, by optimizing shading design and wall heat capacity coefficient, the indoor PMV value of the building before optimization was 1.4 in summer, but after optimization, it decreased to 0.6 and PPD decreased to 12%. By reducing the duration of direct sunlight, the fluctuation range of indoor temperature has been reduced by 30%, significantly improving the thermal comfort of residents. In addition, experimental data shows that using can reduce the operating time of air conditioning systems by about 18% -22%, thereby achieving a significant reduction in building energy consumption.

Based on the comprehensive research results, this study proposes several key optimization suggestions for interior design parameters: reasonable arrangement of window size and position, and reducing indoor temperature in summer through natural ventilation; Select materials with high thermal conductivity and high heat capacity to enhance the thermal buffering performance of the wall; Reasonable shading design and use of shading equipment to reduce the time and intensity of direct sunlight in summer. Through the above strategies, the different can be significantly improved. Experimental data shows that the optimized buildings have reduced energy consumption by about 15% -25%. This study is based on the principle of dynamic heat dissipation in the environment and parameter optimization of thermal comfort standards, providing scientific guidance and data support for building design, and having a positive impact on building energy efficiency and living environment comfort.

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REFERENCES

- [1] Bai J., Fan H., Cui S., Wang L., He S., Chen M., and Zheng H., 2024. Experimental study of phase change heat dissipation system based on hydrogen fuel cell. *Case Studies in Thermal Engineering* 59: 104495.
- [2] Chen H., Zhang H., Wu S., Liu Y., and Zhong H., 2024. Numerical simulation and optimization design for ventilation and heat dissipation in high-temperature and high-load indoor substations. *Case Studies in Thermal Engineering* 59: 104502.
- [3] Fan W., Shi C., Liu W., and Liu Z., 2024. Optimal height distribution design and experimental validation of pin-fin heat sink under natural convection based on dynamic surrogate model. *International Communications in Heat and Mass Transfer* 158: 107962.
- [4] Han C., He L., Tian Z., Xu B., and Chen Z., 2022. Study of heat dissipation characteristics of loop heat pipe with heat sink of composite material. *Applied Thermal Engineering* 200: 117572.
- [5] Karanafti A. and T. Theodosiou. 2024. Summer thermal performance analysis of an Opaque ventilated Façade operating under the dynamic insulation principle. *Energy and Buildings* 312: 114193.
- [6] Li G., Bu S., Yang X., Liang K., Shao Z., Song X., Wu H., Tang Y., and Zong D., 2024. Thermodynamic, economic, and environmental analyses and multi-objective optimization of an organic flash regenerative cycle with an ejector for geothermal heat utilization. *Thermal Science and Engineering Progress* 54: 102853.
- [7] Min C., Yang X., Wang K., Yuan Y., and Xie L., 2019. An inverse optimization of convection heat transfer in rectangle channels with ribbed surface based on the extremum principle of entrance dissipation. *International Journal of Heat and Mass Transfer* 130: 722-732.
- [8] Tan Q., Zhu H., Zhao H., Yang S., Yang X., and Huang C., 2024. Investigation of a new sustainable precast carpeted asphalt ultra-thin overlay: Structural design, dynamic response properties in a real environment, and environmental benefits. *Construction and Building Materials* 450: 138592.
- [9] Wang Z., Gu Y., Lu S., and Zhao Z., 2023. Optimization of thermocline heat storage tank capacity for combined heat and power plant based on environmental benefits: Scenarios for China. *Journal of Energy Storage* 57: 106303.
- [10] Zhang B., Li Y., Chen Z.-F., Wang W., Shi G., and Yang H., 2024. Numerical study on heat dissipation of double layer enhanced liquid cooling plate for lithium battery module. *International Journal of Thermal Sciences* 206: 109329.
- [11] Zhang J., Wang C., Zhang H., Shu C.-M., Zhang M., and Wang X., 2023. Optimization study of vehicle thermal management based on vibration heat dissipation. *Applied Thermal Engineering* 224: 120058.
- [12] Babich F., Torriani G., Corona J., and Lara-Ibeas I., 2023. Comparison of indoor air quality and thermal comfort standards and variations in exceedance for school buildings. *Journal of Building Engineering* 71: 106405.
- [13] Elnaklah R., Alnuaimi A., Alotaibi B.S., Topriska E., Walker I., and Natarajan S., 2021. Thermal comfort standards in the Middle East: Current and future challenges. *Building and Environment* 200: 107899.
- [14] Gao Y., Gao Y., Wang Z., and Lv Y., 2024. Research on the effect of exercise behavior on thermal comfort and heating degree days in sports buildings. *Applied Thermal Engineering* 253:

- 123668.
- [15] Geck C.C., Alsaad H., Voelker C., and Smarsly K., 2024. Personalized low-cost thermal comfort monitoring using IoT technologies. *Indoor Environments* 1 (4): 100048.
 - [16] Guo F., Ham S.W., Kim D., and Moon H.J., 2025. Deep reinforcement learning control for co-optimizing energy consumption, thermal comfort, and indoor air quality in an office building. *Applied Energy* 377: 124467.
 - [17] Hu D., Xue H., Qiu C., and Wang J., 2025. Real-time prediction model of passenger thermal comfort for intelligent cabin. *International Journal of Thermal Sciences* 207: 109370.
 - [18] Landuyt L., Turck S.D., Laverge J., Steeman M., and Bossche N.V.D., 2021. Balancing environmental impact, energy use and thermal comfort: Optimizing insulation levels for The Mobble with standard HVAC and personal comfort systems. *Building and Environment* 206: 108307.
 - [19] Sadeghian G., Tahbaz M., and Hakimian P., 2024. Urban microclimate analysis: Residential block morphology impact on outdoor thermal comfort. *Proceedings of the Institution of Civil Engineers-Engineering Sustainability* 177 (5): 309-319.
 - [20] Shi Z., Zheng R., Zhao J., Shen R., Gu L., Liu Y., Wu J., and Wang G., 2024. Towards various occupants with different thermal comfort requirements: A deep reinforcement learning approach combined with a dynamic PMV model for HVAC control in buildings. *Energy Conversion and Management* 320: 118995.
 - [21] Sun Z., Zhao S., Gao S., Yan H., Yang L., and Zhai Y., 2024. Revisiting the adaptive thermal comfort zone in ISO 17772-1 standard: Insights from four thermal comfort databases. *Energy and Buildings* 324: 114917.
 - [22] Xi H., Wang B., and Hou W., 2024. Machine learning-based prediction of indoor thermal comfort in traditional Chinese dwellings: A case study of Hankou Lifen. *Case Studies in Thermal Engineering* 61: 105048.
 - [23] Zhang S. and Z. Lin. 2020. Standard effective temperature based adaptive-rational thermal comfort model. *Applied Energy* 264: 114723.
 - [24] Chen C.-H., Lee Y.-C., and Chen A. Y., 2021. A Building Information Model enabled Multiple Traveling Salesman Problem for building interior patrols. *Advanced Engineering Informatics* 47: 101237.
 - [25] Kamal M.A., Alam M.M., Sajak A.A.B., and Su'ud, M.M., 2024. SNR and RSSI Based an Optimized Machine Learning Based Indoor Localization Approach: Multistory Round Building Scenario over LoRa Network. *Computers, Materials and Continua* 80 (2): 1927-1945.
 - [26] Mazumdar A., Burkotová J., Krátký T., Chugh T., and Miettinen K., 2024. Handling simulation failures of a computationally expensive multiobjective optimization problem in pump design. *Engineering Applications of Artificial Intelligence* 136: 108897.