

Problem B

Optimization of the Shape of Air conditioner

With the continuous improvement of people's requirements for quality of life, products that combine air conditioning, humidifiers, and air purifiers have gradually been developed. It is a multifunctional environmental conditioning device. The three in one product only occupies the space of one device, instead of placing air conditioners, humidifiers, and air purifiers separately like traditional methods.



Figure 1. Schematic diagram of air conditioner, humidifier, and air purifier.

Air conditioning may make indoor air dry while regulating temperature. The humidifier in the three in one product can replenish moisture in a timely manner and maintain suitable indoor humidity. Air purifiers can filter harmful pollutants such as dust, pollen, smoke, and formaldehyde in the air. When the air conditioner is running and causing indoor air circulation, the air purifier can better function, purify the circulating air, and improve indoor air quality. Users can simultaneously control the opening, closing, and adjusting related parameters of three functions without the need to operate three different devices separately. The three in one product

of air conditioner, humidifier and air purifier also reduces the power and connection wires of multiple devices, reduces the complexity of wiring, makes the indoor environment more concise and beautiful, and also reduces the safety hazards that may be caused by too many lines.

The optimal design of the three in one air conditioner, humidifier, and air purifier is closely related to aerodynamics. The overall shape, placement, position and quantity of air inlet and outlet, direction and angle, wind speed and air volume of the three in one environmental conditioning equipment will all affect its effectiveness.

There is currently a room that is about to be renovated, which can be approximated as a long square with a spatial volume of $5\text{m} \times 8\text{m} \times 3\text{m}$. The maximum volume of the limited three in one air conditioner is 0.1 m^3 , the rated power consumption is 1800W, the maximum air outlet speed is 8.0 m/s, the maximum inlet flow rate of the airflow is $600 \text{ m}^3/\text{hour}$, and the maximum outlet flow rate of the airflow is also $600 \text{ m}^3/\text{hour}$.

As the manager of the APMCM three-in-one air conditioner appearance optimization team, please collect and research relevant data on air conditioners, humidifiers, and air purifiers in the market, and then establish a mathematical model for optimizing the appearance of the three in one air conditioner. Answer the following questions:

Question 1: Please analyze the influence of factors such as the placement of air conditioning, the position and quantity of air inlet and outlet, direction and angle, wind speed and air volume on the efficiency of air conditioning, and simulate the changes in indoor temperature over time and space under different conditions in summer and winter. Then consider the different shapes of the air conditioner, establish an optimization model for the shape of the air conditioner, and design the optimal shape and size of the air conditioner to achieve the best temperature regulation effect.

Question 2: Please analyze the influence of the shape of the air purifier on the purification effect, consider different shapes of the air purifier, establish an optimization model for the shape of the air purifier, design the optimal shape and size of the air purifier to maximize the purification effect, and draw the shape and size parameters of the optimal shape.

Question 3: Please analyze the influence of the shape of the air humidifier on the humidification effect, consider different shapes of the air humidifier, establish an optimization model for the shape of the air humidifier, design the optimal shape of the air humidifier to maximize the humidification effect, and draw the shape and size parameters of the optimal shape.

Question 4: Based on the models and results in questions 1-3, please establish an

optimized design model for the appearance of the three in one air conditioner, humidifier, and air purifier, while maximizing energy efficiency, human comfort, purification effect, and humidification effect. Design the optimal appearance of the three in one device and draw the shape and size parameters of the optimal appearance.

Glossary :

Aerodynamics: Aerodynamics is a branch of fluid mechanics that mainly studies the interaction forces between gases and objects when objects move in air or other gases, as well as the flow of gases around objects. Simply put, it focuses on the dynamic relationship between air and objects, including the generation of forces, energy conversion, and flow patterns, among many other aspects.