Dehumidification, Anti-haze, Heat Insulation Nano Composite Gauze Structure

Abstract

The invention provides a dehumidification, haze prevention and heat insulation Nano composite yarn structure, which is formed by multi-layer Nano coating treatment with a Polyethylene Terephthalate (PET) mesh substrate as the base. The outer layer of the structure is a super-hydrophobic self-cleaning Nano-coating that can effectively prevent the adhesion of water droplets and dust; the middle layer uses a Metal Organic Framework (MOF) or graphene coating combined with a Polytetrafluoroethylene (PTFE) microporous membrane to achieve efficient dehumidification and air filtration, especially for PM2.5 and above particles; the inner layer combines a Low-Emissivity (Low-E) insulation film and a Phase Change Material (PCM) microcapsule layer to play a role in insulation and heat regulation. This structure can improve indoor air quality in high haze and high humidity environments while reducing energy consumption. It is suitable for building exterior windows, vehicle screens and indoor ventilation systems.

【Designated representative figure】Figure 1

[Brief explanation of the symbols in the representative diagram]

1. Outer layer - super hydrophobic Nano coating
2. Middle layer - dehumidification and filtration layer
3. Inner layer - insulation and regulation layer
4. Polyethylene Terephthalate (PET) mesh substrate

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Specification

【Technical field】

[0001] The present invention relates to the field of environmentally friendly building materials, and specifically to a Nano-composite mesh structure integrating dehumidification, air filtration and heat insulation, which is particularly suitable for improving indoor and outdoor air quality and energy consumption control in high haze and high humidity environments.

【Prior Art】

[0002] The common mesh materials on the market currently mainly provide air filtration functions (such as anti-smog screens) or partial heat insulation effects, but there is still a lack of a composite material that can integrate dehumidification, filtration and heat insulation at the same time. In the existing technology, the dehumidification function mostly relies on a single hygroscopic material, while the thermal insulation material is mainly used in the fields of glass and membrane materials. The degree of technical integration is insufficient, making it difficult to operate stably for a long time in a high haze environment.

【New content】

[0003] The invention provides a nano-composite yarn mesh structure with three effects of dehumidification, haze prevention and heat insulation. The structure realizes comprehensive regulation of ambient air quality through the integrated design of multi-layer Nano-technology. Compared with the existing technology, this new type has the following innovations:

Multifunctional integrated design-

Traditional mesh materials only have basic ventilation and dust prevention functions, while this new type realizes the organic combination of dehumidification, anti-haze and heat insulation through the design of multi-layer structure. Its structure is

Using polyethylene terephthalate (PET) mesh substrate as the carrier, its fiber diameter is about 15-30μm, and the following multi-layer Nano coatings are deposited on the surface of the substrate in sequence:

Inner layer, infrared reflection low-radiation (Low-E) film and phase change material (PCM) microcapsule layer (total thickness of about 2.0 μm) are applied to provide excellent heat insulation and heat regulation effects;

In the middle layer, metal organic framework (MOF) or graphene coating is deposited, and then covered with polytetrafluoroethylene (PTFE) microporous membrane (total thickness of about 1.5 μm) to achieve dehumidification and high-efficiency air filtration, especially for PM2.5 and above particles;

Outer layer, super hydrophobic Nano coating (thickness of about 200nm) is used to imitate the lotus leaf effect to achieve self-cleaning and waterproofing.

High-efficiency haze filtering and dehumidification technology-

Through metal organic framework (MOF) or graphene Nano coating, combined with polytetrafluoroethylene (PTFE) microporous membrane, this material combination can effectively intercept PM2.5 and above pollutants in the air, and has a filtration efficiency of more than 90%.

The dehumidification function uses the microporous structure and surface hydrophilicity of the metal organic framework (MOF) material to capture water molecules in the air and discharge the water outward through the airflow path to achieve air humidity regulation.

Thermal energy regulation mechanism-

The inner layer of infrared low-emissivity (Low-E) film and phase change material (PCM) microcapsules can work together to effectively reduce indoor temperature fluctuations by reflecting infrared rays and absorbing

and releasing heat energy. The phase change temperature of the phase change material (PCM) microcapsules is set at 25°C to 35°C, which can adapt to most environmental conditions and provide long-term thermal regulation.

Super hydrophobic self-cleaning technology-

The super hydrophobic Nano coating on the outer layer has a water contact angle of not less than 160°, which can effectively prevent water droplets and polluted particles from adhering, ensuring that the gauze maintains high air permeability and cleanliness for a long time, reducing maintenance costs.

Applicability and environmental protection-

This structure is suitable for building exterior windows, vehicle screens and indoor ventilation systems, which can improve air quality and reduce air conditioning energy consumption, thereby reducing carbon emissions, in line with the development trend of environmental protection and energy conservation.

This novel type breaks through the single function limitation of traditional gauze. Through the design of multi-layer nanostructure, it effectively realizes the synergistic effect of dehumidification, anti-haze and heat insulation, which not only improves the comfort of the indoor environment, but also has the advantages of high efficiency, low energy consumption and convenient self-cleaning maintenance, and has great market application potential.

【Simple explanation of the diagram】

[0004]

Figure 1-Schematic diagram of the structure of the new model

Figure 2-Schematic diagram of the molecular structure of each layer of the new model

Figure 3-Schematic diagram of the barrier of different molecules in the dehumidification, anti-haze and heat insulation environment of the new model

Figure 4-Schematic diagram of the airflow path of the new model

Figure 5-Simulated time series diagram of the efficiency change of the new model under dynamic conditions

Figure 6-Efficiency distribution of the new model under different conditions

Figure 7-Sensitivity analysis diagram of the new model

Figure 8-Statistical distribution diagram of the new model - histogram

Figure 9-Performance optimization diagram of the new model - removal efficiency vs airflow resistance

【Implementation】

[0005] Refer to Figures 1 and 2. The present invention provides a dehumidification, anti-haze, and heat-insulating Nano-composite gauze structure, which is manufactured from bottom to top in sequence: first, an inner layer of heat-insulating and regulating layer 3 is deposited on a polyethylene terephthalate (PET) mesh substrate 4, a low-emissivity (Low-E) film is deposited on its surface, and microcapsules containing phase change material (PCM) molecules 6 are evenly distributed. Next, a middle layer of dehumidification and filtration layer 2 is deposited, including metal organic framework (MOF) molecules 7 or graphene Nano-coatings, and covered with polytetrafluoroethylene (PTFE) molecules 8 microporous membranes. Finally, an outer layer of super-hydrophobic Nano-coating 1 is deposited by spraying or dipping, and cured to ensure uniform coverage.

【Description of symbols】

[0006]

1. Super hydrophobic Nano coating

2. Dehumidification and filtration layer

3. Heat insulation and regulation layer

4. Polyethylene terephthalate (PET) mesh substrate

5. Polyethylene terephthalate (PET) molecule
6. Phase change material (PCM) molecule
7. Metal organic framework (MOF) molecule
8. Polytetrafluoroethylene (PTFE) molecule
9. Super hydrophobic Nano coating molecule
10. Heat source
11. Pollution particle
12. Water molecule
13. Airflow path
14. Water is discharged to the outside
15. Dehumidification efficiency
16. Anti-haze efficiency
17. Thermal insulation efficiency
18. Standard test conditions (such as 25°C, normal humidity, normal pressure)
19. Harsh environmental conditions (such as high temperature, humidity, and dust)
20. Optimized conditions (e.g. surface modification, nanostructure or advanced coating)
21. Outliers
22. Ideal optimization goal (low air flow resistance, high removal efficiency)

Dehumidification, Anti-haze, Heat Insulation Nano Composite Gauze Structure

Claim

[Claim 1] A dehumidification, anti-haze, and heat-insulating nanocomposite yarn structure, the structure comprising:

A polyethylene terephthalate (PET) mesh substrate, which is composed of fibers with a diameter of about 15-30 μm;

A heat-insulating and regulating layer is formed on the surface of the polyethylene terephthalate (PET) mesh substrate from bottom to top, the layer includes an infrared reflective low-emissivity (Low-E) film and a phase change material (PCM) microcapsule, with a total thickness of about 2.0 μm;

A dehumidification and filtration layer, composed of a metal organic framework (MOF) or graphene Nano coating and a polytetrafluoroethylene (PTFE) microporous membrane, with a total thickness of about 1.0-1.5 μm;

A super hydrophobic Nano coating, with a thickness of about 100-300 nm.

[Claim 2] The dehumidification, anti-haze, and heat-insulating nanocomposite gauze structure according to claim 1, wherein the polyethylene terephthalate (PET) mesh substrate is composed of a woven structure, which provides sufficient mechanical strength and weather resistance.

[Claim 3] The dehumidification, anti-haze, and heat-insulating nanocomposite gauze structure according to claim 1, wherein the super hydrophobic Nano coating has a water contact angle of not less than 160° to achieve self-cleaning and waterproof effects.

[Claim 4] The dehumidification, anti-haze, and heat-insulating nanocomposite gauze structure according to claim 1, wherein the

dehumidification and filtration layer can achieve at least 90% filtration efficiency for PM2.5 and above particles.

[Claim 5] The dehumidification, anti-haze, and heat-insulating nanocomposite gauze structure according to claim 1, wherein the low-emissivity film in the heat-insulating and regulating layer is selected from metal oxides or other low-emissivity materials, and synergizes with phase change material (PCM) microcapsules to achieve thermal energy regulation.

[Claim 6] The dehumidification, anti-haze, and heat-insulating nanocomposite gauze structure according to claim 1, wherein the phase change temperature of the phase change material (PCM) microcapsules is set between 25°C and 35°C so as to perform thermal regulation under normal environmental conditions.

[Claim 7] The dehumidification, anti-haze, and heat-insulating nanocomposite gauze structure according to claim 1, wherein the layered structure comprises:

Inner layer: a low-emissivity film is deposited on the surface of a polyethylene terephthalate (PET) mesh substrate, and the phase change material (PCM) microcapsules are evenly distributed;

Middle layer: a metal organic framework (MOF) or graphene Nano coating covering the inner layer, and a polytetrafluoroethylene (PTFE) microporous membrane attached to the coating;

Outer layer: a super hydrophobic Nano coating deposited on the surface of the middle layer.

[Claim 8] The dehumidification, anti-haze, and heat-insulating nanocomposite gauze structure according to claim 1, wherein the outer super-hydrophobic Nano coating is prepared by spraying or dipping, and the coating thickness after curing is 50-200nm, and the contact angle is greater than 150°.

[Claim 9] The dehumidification, anti-haze, and heat-insulating nanocomposite gauze structure according to claim 1, after the synergistic effect of the structure, the structure can reduce the indoor PM2.5 concentration by at least 90% in a high haze environment, and improve indoor comfort and reduce energy consumption through heat insulation and dehumidification functions.

[Claim 10] The dehumidification, anti-haze, and heat-insulating nanocomposite gauze structure according to claim 1, the structure is suitable for environments such as building exterior windows, vehicle screens, and indoor ventilation systems, and is used to improve air quality, regulate indoor temperature and humidity, and reduce energy consumption.

Dehumidification, Anti-haze, Heat Insulation Nano Composite Gauze Structure

Figures

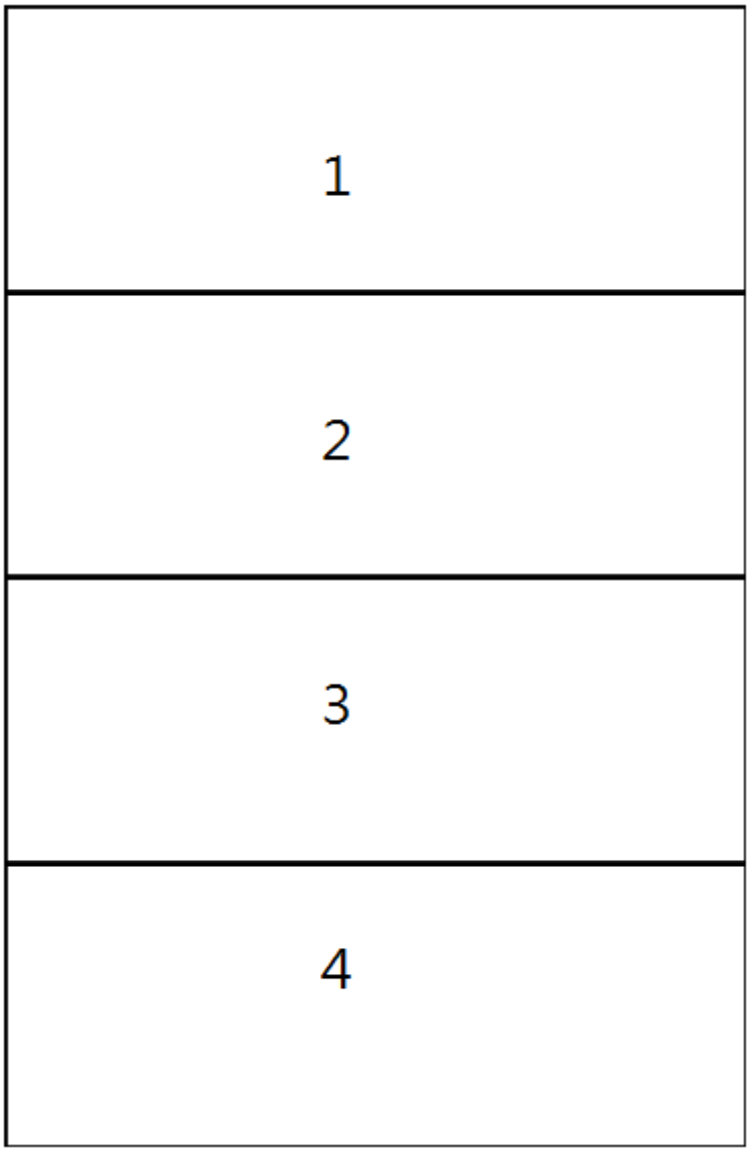


Figure 1.

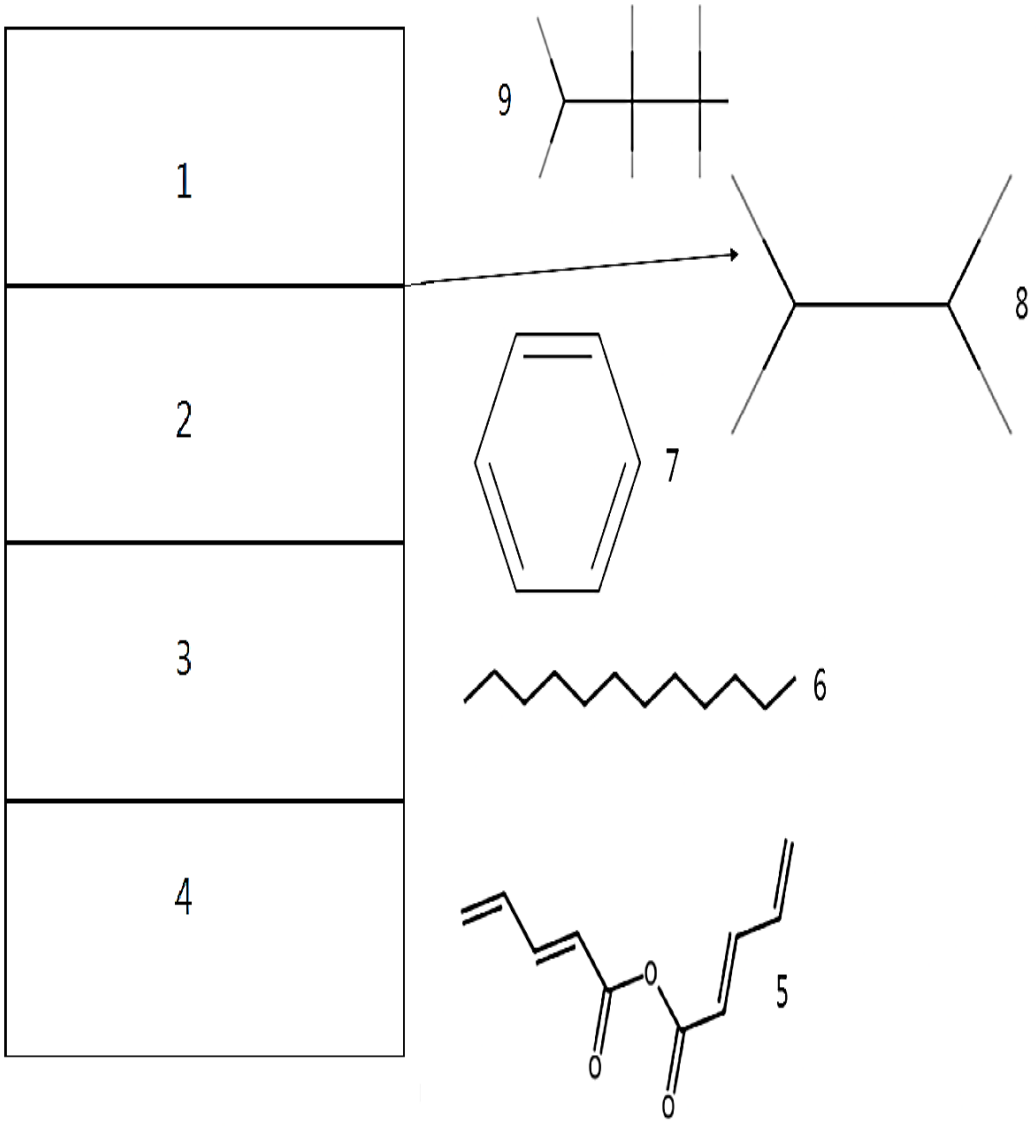


Figure 2.

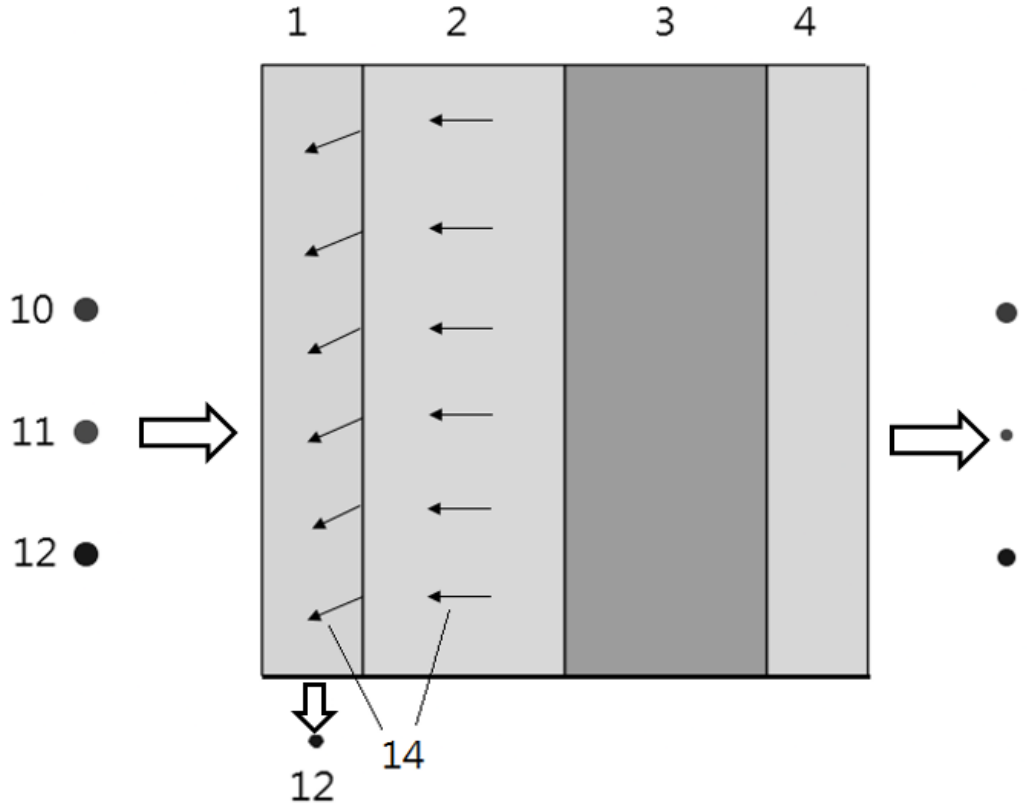


Figure 3.

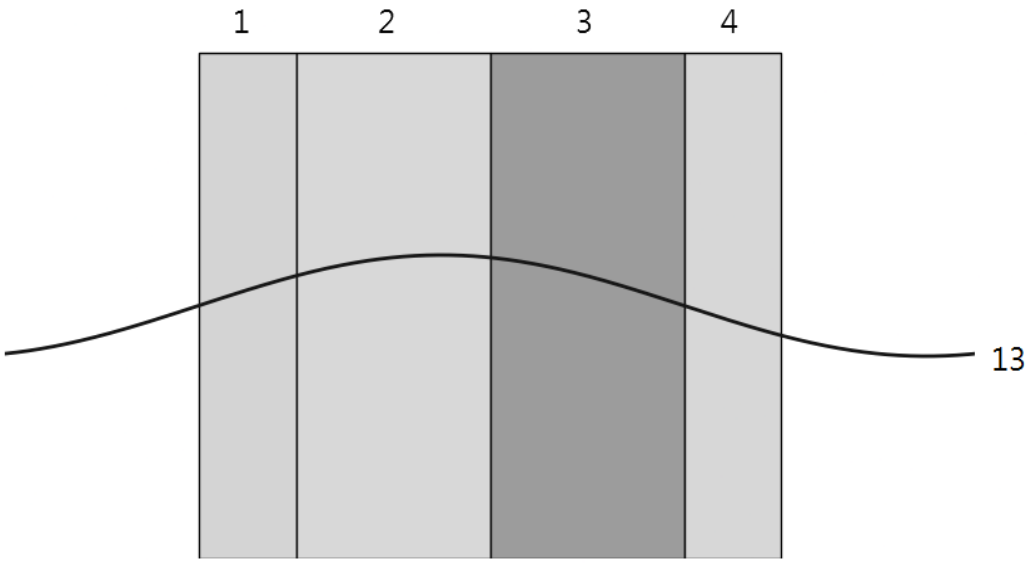
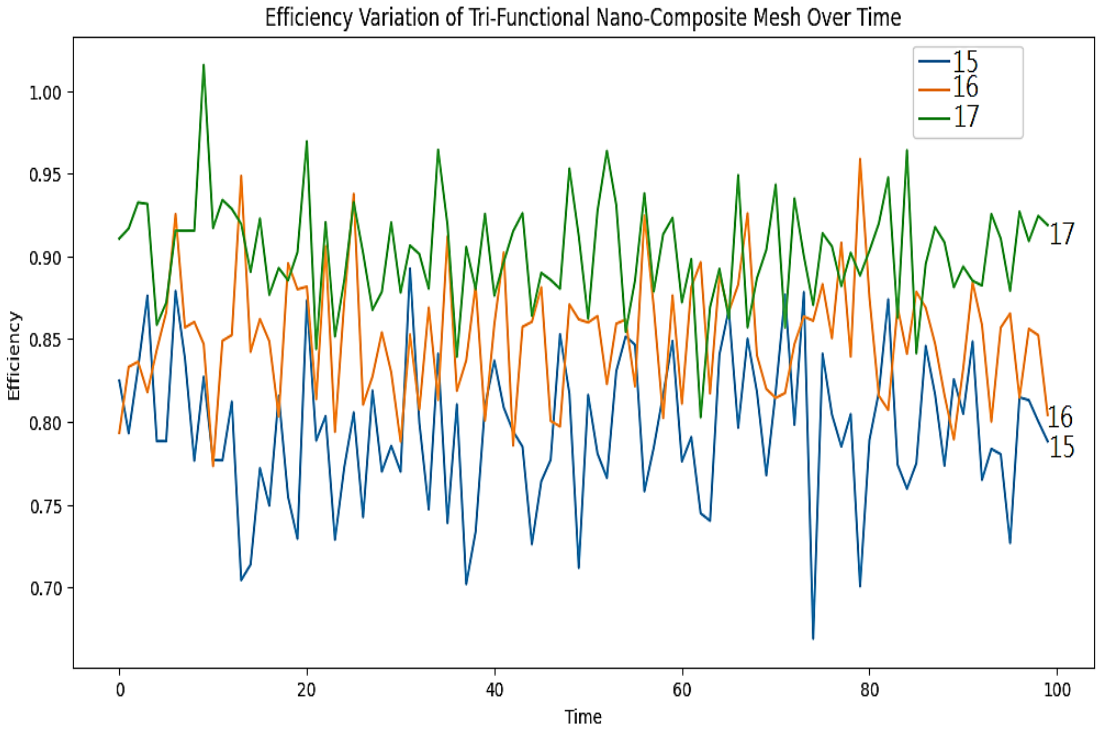


Figure 4.



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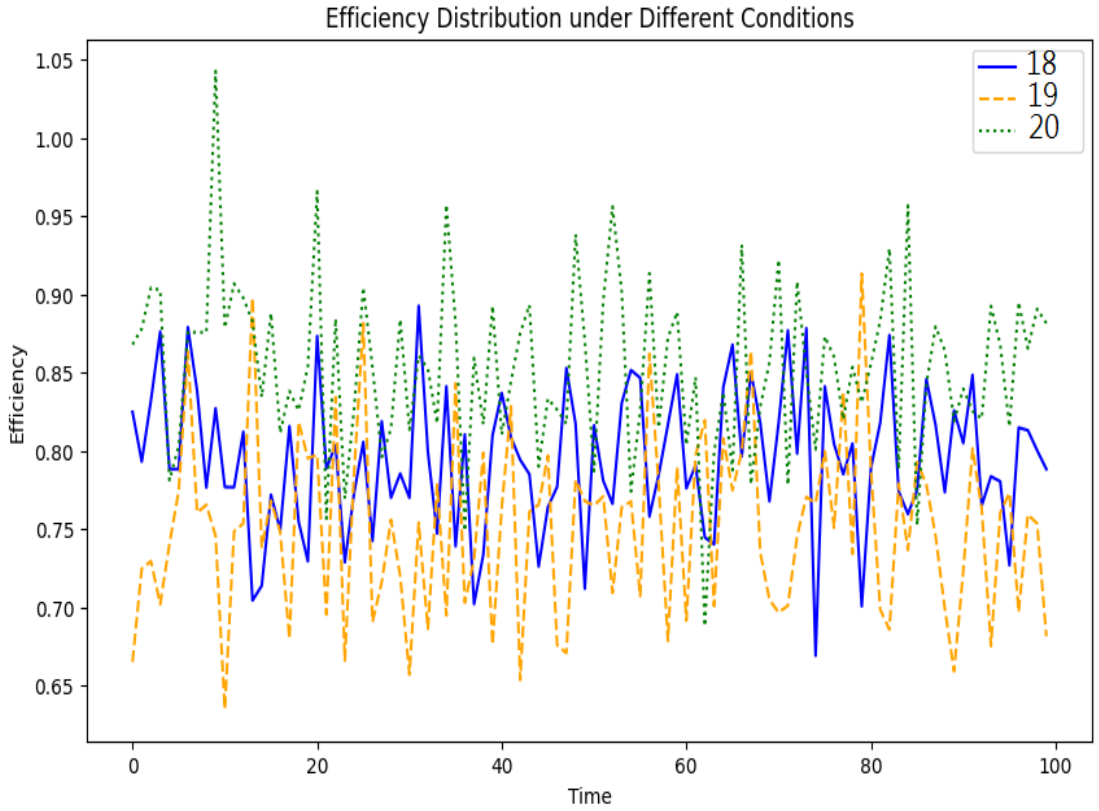

Figure 6.

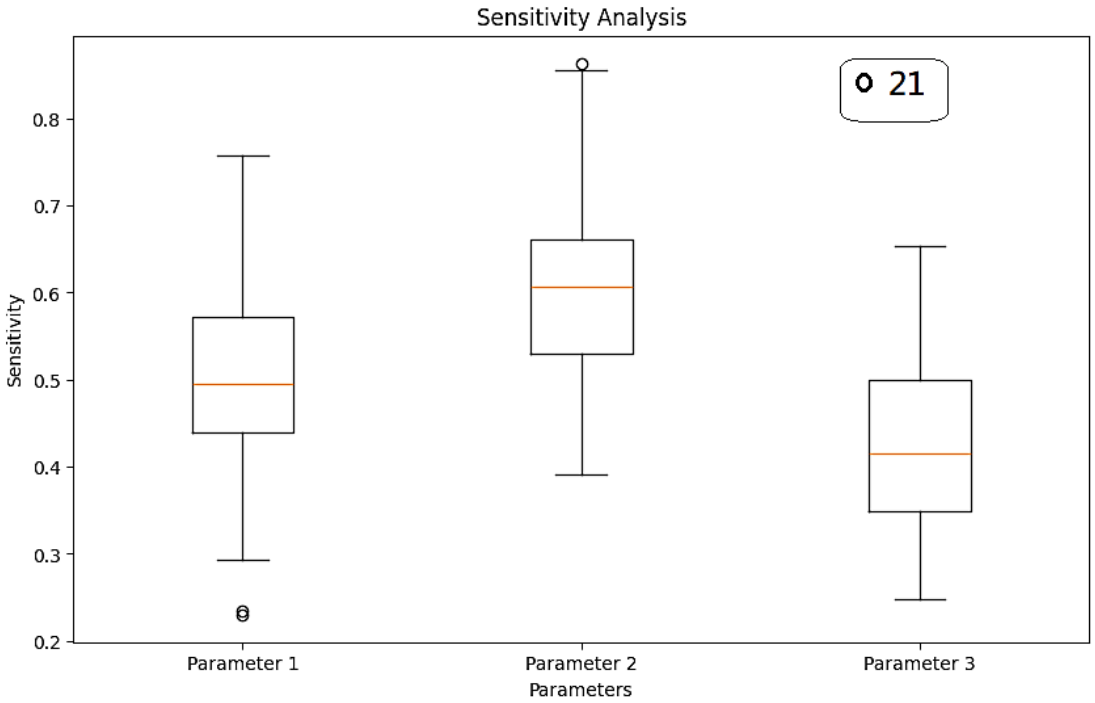

Figure 7.

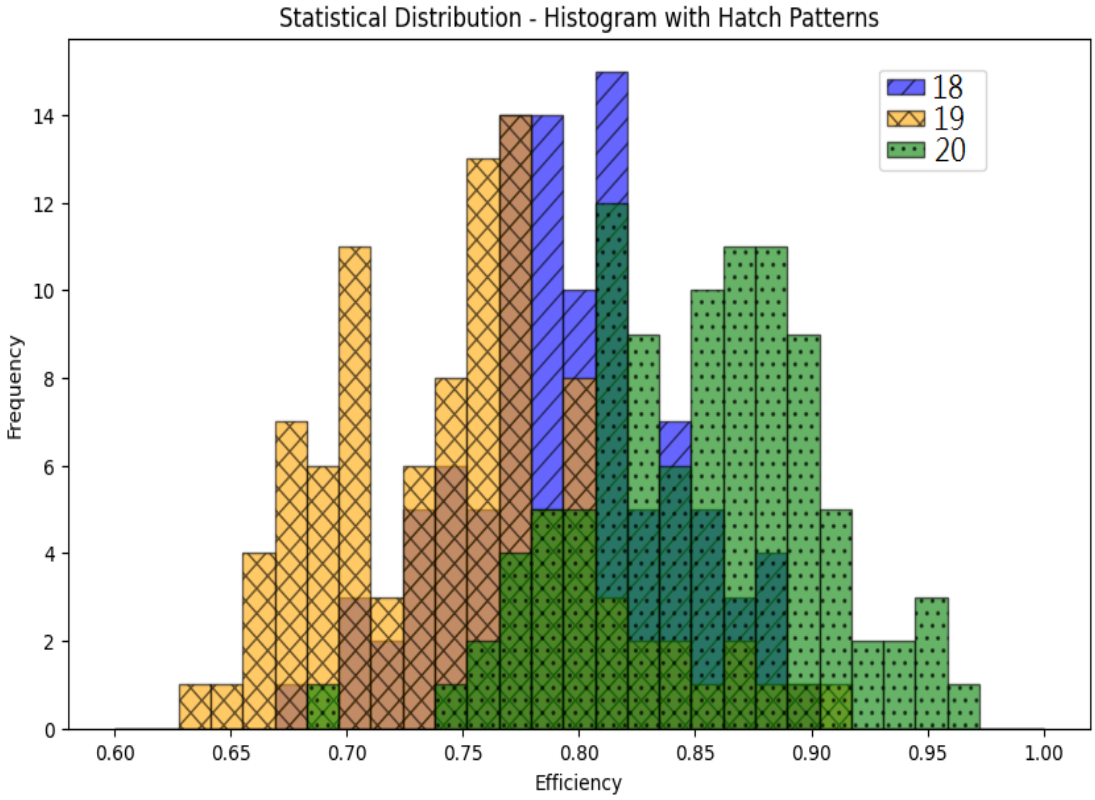

Figure 8.

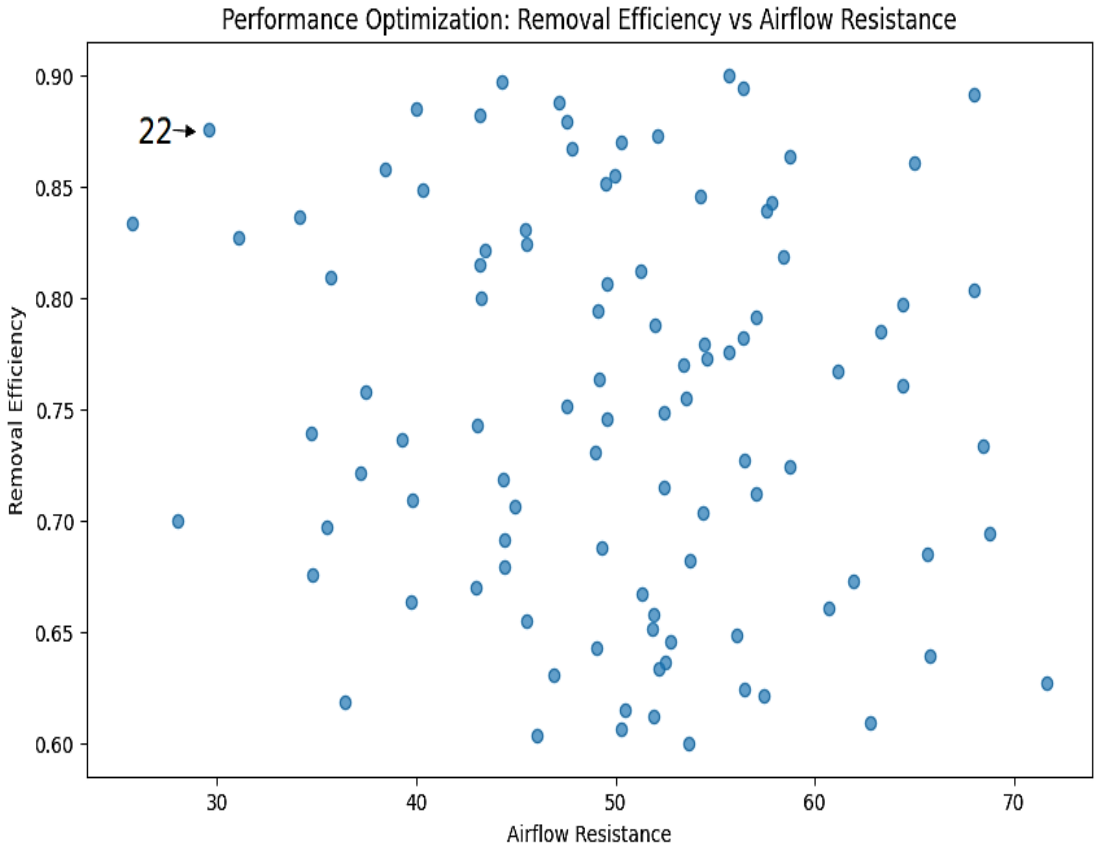
Performance Optimization: Removal Efficiency vs Airflow Resistance
22
Removal Efficiency
0.90
0.85
0.80
0.75
0.70
0.65
0.60
30
40
50
60
70
Airflow Resistance

Figure 9.