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Structure Design and Simulation Analysis of Household Intelligent Humidifier Dehumidifier

Qingxin Hu, Yueyun Fang*

School of Mechanical and Electrical Engineering, Guangdong University of Science and Technology, Dongguan, Guangdong, China

*Corresponding author: yy0213@mail.ust.edu.cn

Abstract

The research shows that the quality of indoor environment directly affects people's physical and mental health, comfort and work efficiency. In view of the defects of the existing humidification and dehumidification integrated machine in the current market, this design integrates the humidification and dehumidification functions on the basis of retaining its original functions. The internal structure is mainly divided into upper and lower working areas. The upper working area is a dehumidification area, which thoroughly purifies the inhaled air by inhaling moist air, and then filters it through a six fold filter screen. After dehumidification, it is discharged, making the discharged air more environmentally friendly and healthy. The humidification work area is mainly concentrated in the lower half of the area. First, the condensed water generated in the dehumidification process is recycled, and the condensed water is purified by a condensate purifier. When humidified, it can be recycled to achieve resource recovery.

Keywords

Household, Intelligence, Humidification and Dehumidification, Purification, Recycling.

1. Introduction

With the continuous growth of social economy and the continuous improvement of science and technology, people's demand for life and work has become more and more modern, and people are more engaged in indoor work, entertainment and leisure[1]. According to statistics, people spend more than 80% of their time indoors on average. Therefore, people's physical and mental health, work efficiency and comfort are often directly affected by the quality of indoor environment. Some experts believe that if the indoor environment is properly improved and improved, the work efficiency of employees will be increased by 15%-20%. Therefore, the relationship between human health and indoor air quality is particularly important[2].

At present, the more mature products of humidification and dehumidification all-in-one machine are mostly split type large-scale industrial constant humidity units (on the basis of indoor condenser, outdoor additional air-cooled or water-cooled condenser). The indoor units of this kind of products generally have the disadvantages of large equipment volume, difficult installation and high cost. They are not suitable for the environment where the space of family room, laboratory, hospital ward, archives room, precision instrument room is relatively narrow and inconvenient to install the split unit[3]. The design of this topic is a kind of household intelligent humidification and dehumidification integrated machine. Through ingenious design of all the main components of the system, an integral movable body similar to mobile air conditioning is designed, which avoids the trouble of installation and is convenient for users' mobile use. Secondly, the development of household intelligent humidification and dehumidification integrated machine is not mature. At present, most of the intelligent humidification and dehumidification integrated machines in the market are used to realize the

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single function of humidification or dehumidification. This design topic aims at the humidification and dehumidification integrated machine. On the basis of retaining its original function, the humidification function and dehumidification function are integrated, which not only realizes the integration of functions, but also uses the ingenious cycle design to recycle the condensate through the purification system, so as to realize the recycling of resources and play an environmental protection role. At the same time, the design has greatly upgraded the use of the filter screen. It adopts the form of multiple filter screens to thoroughly purify the inhaled air, making the discharged air more environmentally friendly and healthy[4].

2. Structural Design

The intelligent humidification dehumidification machine in this design is mainly composed of motor, six filter screen, compressor, evaporator, condenser, fan, water tank, steam trap, atomizer, centrifugal pump and purifier. The humidification and dehumidification integrated machine in this design is different from the traditional one in the use of filter screen and the selection of purifier. The filter screen adopts six fold filter screen to thoroughly purify the wet air inhaled, while the purifier is specially used to purify the condensed water, so that the condensed water can reach the edible level and then be discharged through the atomizer to ensure the health and environmental protection of the discharged air. At the same time, it also realizes the resource circulation and plays the role of energy conservation and environmental protection[5].

From the perspective of safety, we designed the shape of the humidification and dehumidification machine into a cylindrical shape. The appearance of the column is smooth and free of edges and corners, which not only meets the aesthetic requirements of the public, but also prevents children from bumping and other situations[6].

From the convenience point of view, this design uses a detachable shell, which is convenient to disassemble the water tank and other items that need cleaning for cleaning. The overall design is shown in Figure 1.

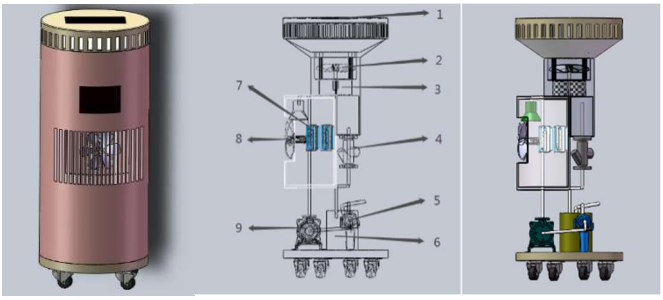

Figure 1. Overall design of humidification and dehumidification machine and internal structure diagram

1-display touch screen, 2-Fan, 3-filter screen, 4-trap, 5-condensate purifier, 6-water tank, 7-evaporator, condenser, 8-exhaust fan, 9-centrifugal pump

As shown in Figure 2, the interior of the humidifier dehumidifier is mainly divided into upper and lower half areas. The upper half of the area is the distribution of the main components of the humid air inlet and dehumidification function. The humid air is sucked in by the fan and filtered by the filter screen, enters the purified air storage area, and is pressed into the drying shield. After treatment by the evaporator and condenser, the dry air is formed, and finally is discharged from the machine through the fan and enters the room. The lower half area is the main parts of humidification function, including water tank, purifier and centrifugal pump.

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Considering the convenience of disassembly and installation, the three parts of humidification function are placed at the bottom of the machine.

3. Static Stress Analysis

The object of this static stress analysis is the shell. Since the shell is the main support of the whole machine, it is necessary to conduct a static stress analysis. The shell of household humidification dehumidification machine mainly bears the weight of touch screen, aluminum shell, fan, filter cover and filter screen[7].

The calculation mainly uses the mass calculation formula and gravity calculation formula:

$$m=\rho V$$

Where: m--mass

P--Density

V--Volume

$$G=mg$$

G--gravity

M--mass

g--gravitational acceleration

Touch screen quality: according to the market survey, the overall quality of the 7-inch touch screen is about 400g;

Quality of aluminum shell: the density of aluminum shell is.

The outer diameter, inner diameter, height and wall thickness of the aluminum shell are 20mm. According to the calculation of the cylinder volume formula, the volume of the outer hub of the aluminum shell is:

$$V=\pi R^2H-\pi r^2h=\frac{\pi D^2}{4}\times H-\frac{\pi d^2}{4}\times h=\frac{3.14\times 400^2}{4}\times 80-\frac{3.14\times 380^2}{4}\times 60$$
$$=10048000-6801240=3246760mm^3 \quad (\pi=3.14)$$

In order to facilitate gas suction, 36 rectangular air inlets with a height of 50mm are cut off around the aluminum shell. Through calculation, the volume of air inlet of aluminum shell is

$$V_{\text{Air inlet}}=\frac{5^\circ\times 36}{360^\circ}\left(\frac{\pi D^2}{4}\times H-\frac{\pi d^2}{4}\times H\right)=\frac{1}{2}\times\left(\frac{3.14\times 400^2}{4}\times 50-\frac{3.14\times 380^2}{4}\times 50\right)$$
$$=\frac{1}{2}\times(6280000-5667700)=\frac{1}{2}\times 612300=306150mm^3 \quad (\pi=3.14)$$

To sum up, the volume of the aluminum shell is equal to the volume of the outer hub minus the volume of the air inlet, it can be obtained by calculation: $V_{\text{Aluminum housing}}=3246760-306150=2940610mm^3=2940.61cm^3$. The mass of the aluminum housing can be calculated according to the mass = ρv=2.7×2940.61=7939.647g≈7.94kg.

Filter screen mass: for the convenience of calculation, the filter screen is calculated with coconut shell activated carbon as an example, $\rho=0.5\text{-}0.55g/cm^3$. The density of coconut shell activated carbon is obtained through investigation, and the volume of filter screen is obtained through calculation, $v=655632mm^3=655.632cm^3$. The mass of the filter screen is calculated according to the formula, m=ρv=0.55×655.632=360.5976g≈0.36kg.

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Quality of mute fan: according to the market survey, the quality of mute fan is about 1.5kg.

To sum up, the total mass of touch screen, aluminum shell, filter screen and mute fan is 10.2kg, and the gravity acceleration g is 9.8n/kg. Therefore, the pressure on the main body of the household dehumidification and dehumidification machine, that is, the overall gravity g on the touch screen, aluminum shell, filter screen and mute fan, is substituted into the data by the gravity formula to get g=99.96n. After the pressure on the main body of the household dehumidification and dehumidification machine is obtained, the static stress analysis of the main body of the household dehumidification and dehumidification machine is carried out through SolidWorks software. The analysis process is as follows, and the process diagram is shown in Figure 2 below.

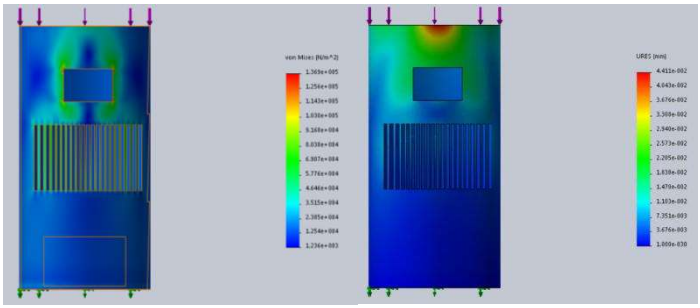

Figure 2. Finite element analysis diagram of shell

Finally, after knowing that the gravity of the main body of the humidification and dehumidification integrated machine is g=99.96n, the static stress analysis of the main body of the humidification and dehumidification integrated machine is carried out in SolidWorks. The analysis results are shown in Figure 4.7. Referring to the relevant ABS data, it is found that the yield strength of the main body of the humidification and dehumidification integrated machine is 50MPa. From the figure, the maximum stress of the main body of the humidification and dehumidification integrated machine is 1.36mpa, which is far from reaching its yield strength, so the strength of the main body of the humidification and dehumidification integrated machine is checked as.

After rough calculation of the pressure on the shell, it is found that the shell bayonet will bear about 99.96n force. By substituting the above data into the static stress analysis of the shell, it can be seen from the figure that the maximum displacement generated by the shell under this pressure is 0.0441mm, which has basically no impact on the shell structure and function of the humidification dehumidification machine, so the displacement generated on the shell can be ignored.

4. Intelligent Control

4.1. Overall Design Scheme

The intelligent control mode of the household intelligent humidification and dehumidification machine designed in this paper is to monitor the indoor humidity through the humidity module, and then drive the motor through the sensor to make the machine humidify or dehumidify. According to scientific data, when the humidity of the air is higher than 65% or lower than 38%, the growth rate of bacteria is the fastest, and when the humidity is between 45% and 55%, the death of bacteria is faster. Therefore, the designed household humidification dehumidification machine sets the humidity module parameters at 45% -55%. When the air humidity is lower than 45%, the humidifier dehumidifier is driven to humidify; When the indoor air humidity is higher than 55%, the humidifier dehumidifier is driven to dehumidify; When the indoor air

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humidity returns to the default range, it will automatically stop working, and play the role of intelligent control and reducing energy consumption. The control block diagram is shown in Figure 3.

All the information parameters of the designed household intelligent humidification dehumidification machine, including indoor humidity monitoring data and machine working state parameters, will be displayed through the display screen, which is convenient for users to understand in real time. At the same time, it will realize touch screen control and mobile phone remote control, which will greatly improve the convenience and realize intelligence.

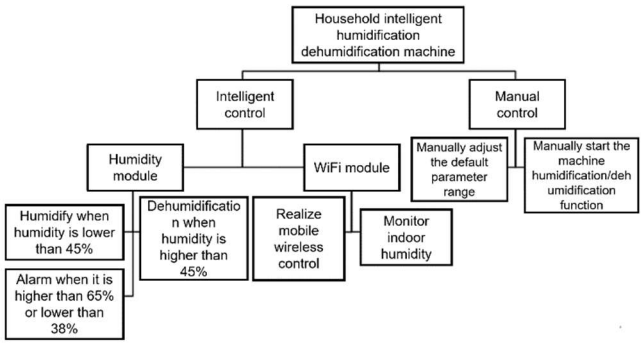

Figure 3. control block diagram

4.2. Humidity Detection Module

The so-called humidity detection module is a product integrating humidity sensor and circuit. In this design, it is mainly used to detect indoor humidity, calculate humidity parameters through voltage output, and then feed back to the host and drive the machine to realize humidification or dehumidification. The sample drawing is shown in Figure 4.

Figure 4. Humidity detection module

4.3. Wi Fi Module

Wi Fi module, also known as serial port Wi Fi module, belongs to the Internet of things transmission layer, and its function is to convert the serial port or TTL level to an embedded module that meets the Wi Fi wireless network communication standard. Traditional hardware devices embedded in Wi Fi module can directly use Wi Fi to connect to the Internet, which is an important part of wireless intelligent control. In this design, the Wi Fi module is embedded in the household intelligent humidification and dehumidification machine, which can realize the remote control of the machine by mobile phones and other intelligent devices, and can realize the real-time monitoring of the machine state, so as to realize the real intelligence.

5. Conclusion

This design first through understanding the development of humidification and dehumidification machine at home and abroad, and the working principle of humidification and dehumidification machine, and then initially determine the design scheme. The design scheme is mainly divided into internal and external design. The internal design is based on the traditional single function machine for transformation and upgrading. The design here mainly

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considers the rationality of the internal structure and the normal operation of various functions. At the same time, through reasonable innovative design, it changes some disadvantages of the traditional humidification and dehumidification machine, such as imperfect air filtration and condensate discharge, so as to achieve high-quality exhaust and resource recycling. Finally, through integrated design, it achieves the purposes of reasonable internal structure, convenient disassembly and efficient work. The external design mainly considers the volume, installation, beauty and feasibility to meet the multi-dimensional needs of family use. After the preliminary determination of the structural design scheme, the feasibility of the layout is studied to clarify its working principle, so that the protective shell such as drying cover is designed and installed to ensure the normal operation of each area and reduce the loss. After completing the main structure design, the main components of the humidification and dehumidification machine are selected, which directly determines the reliability and efficiency of the humidification and dehumidification machine; Finally, the static stress analysis of the main part of the humidification and dehumidification machine is carried out to ensure that the selected materials can meet the requirements, and finally the whole machine design is completed.

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