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INDOOR MICROCLIMATE COMFORT LEVEL CONTROL IN RESIDENTIAL BUILDINGS

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Abstract

The paper investigates research microclimate control in residential buildings. As an indicator of indoor microclimate comfort, indoor air temperature and relative humidity level were considered, and additional influenced factors to temperature and humidity level were factor determined and applied to create comfort parameters. In order to

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ensure comfort microclimate, mathematical model of comfort temperature and humidity level are created and algorithmic process to ensure desired indoor air temperature and humidity level are considered. Results section illustrates the simulation of distributions of indoor temperature and relative humidity level in the residential building.

1. Introduction

A comfortable climate is important for the person in any room where it comes from. To create it in small spaces, we need to keep track of many parameters. They include the ambient temperature, its relative humidity, good ventilation, air velocity. It is particularly important to maintain optimum microclimate in sports premises here include fitness centers and gyms. There are a number of hygienic requirements for heating and ventilation of sports facilities. In life, they are reduced to their adequacy for the room, which hosts athletic training and performed aerobics, exercise or fitness. Such factors as air temperature, light, humidity in the gym must comply with the requirements of sanitary and epidemiological stations.

The most comfortable sports considered air temperature - 18-20°C. Incidentally, the battery should not be heated above 75-80°C, as there is a danger of air pollution due to dust, and burned down the paint. This is unacceptable, because it is difficult for an athlete to breath.

Gyms require more ventilation than living quarters. Usually professional gyms use general dilution ventilation system of channel type. Such systems have the ability to preheat incoming air, which contributes to climate comfort to indoor sports.

In the hot season to maintain optimum air temperature is more complicated. It is better to use a variety of HVAC systems. The small fitness center which can be installed semi-industrial or industrial air conditioners. Today, such an equipment is available to a large number of consumers at low cost having high performance.

There is another indicator that affects the creation of a microclimate in the gym - it is the humidity. The optimal humidity is considered to be in the gym 30-40%. To support such air performance by virtue of the special equipment is currently for sale. There are different humidifiers with regulators and the possibility of installing the required parameters.

2. Algorithmic Process to Ensure Desired Air Temperature and Humidity

Indoor microclimate temperature depends on some factors as outdoor temperature (T_{outdoor}), heat gain from the heating system (Q_{gain}), and fresh air consumption $(G_{\text{fr.air}}(t))$ for ventilation premises. As long as we need to ensure comfort level of the gyms, these three parameters are the most important.

1. Specifically, T_{outdoor} denotes the value of outdoor temperature. The transfer function to change the inside and outside temperatures is as follows:

$$W_{T1}(p) = \frac{T(p)}{T_{\text{outdoor}}(p)} = \frac{1}{(T_T\, p + 1)}, \tag{1}$$

where $T(p)$ is the Laplace image for the indoor temperature, $T_{\text{outdoor}}(p)$ is the Laplace image for the outdoor temperature, and T_T is the time constant.

Temperature changing process includes an inertia property and describes a typical inertial link. In the winter, the process can be characterized by cooling the building with no active heating system and other sources of heat flows affecting the temperature balance.

2. Component $\frac{1}{kF} Q_{\text{gain}}(t)$ considers the effect of the heating system that provides the heat necessary to maintain the heat balance of the room. The transfer function for adjusting the inside air temperature that is influenced by heat is as follows:

$$W_{T2}(p) = \frac{T(p)}{T_{\text{gain}}(p)} = \frac{k_1}{(T_T p + 1)}, \quad (2)$$

where $T(p)$ is the Laplace image for the indoor air temperature, $Q_{\text{gain}}(p)$ is the Laplace transform for the heating system, $k_1 = \frac{1}{kF}$ is the heating system efficiency factor, and T_T is the time constant.

This temperature change process also presents a typical inertial link.

3. Component $-\frac{1}{kF} G_{\text{fr.air}} C_{\text{air}} \Delta T$ considers the cost of heat that is caused by changes in temperature compensation ΔT supply and indoor air in the room. The consumption of fresh air $G_{\text{fr.air}}$ depends on the performance of the ventilation system and considers the value set by the control loop to stabilize the value of the qualitative composition of the air. The relationship between the change in air temperature $T(p)$ and the flow of fresh air $G_{\text{fr.air}}(p)$ is described by the following equation:

$$W_{T3}(p) = \frac{T(p)}{G_{\text{fr.air}}(p)} = \frac{k_2}{(T_T p + 1)}, \quad (3)$$

where $T(p)$ is the Laplace transform for the indoor air temperature, $G_{\text{fr.air}}(p)$ is the Laplace image for fresh air consumption, $k_2 = -\frac{1}{kF} G_{\text{air}} \Delta T$ is the ventilation system efficiency factor, and T_T is the time constant.

The process is inertial and presented by an inertial link. Increases in air flow led to decreases in air temperature, and vice versa, given a condition in which a positive temperature differential was present.

Thus, the indoor air temperature $T(t)$ is an object of control that can represent a dynamic system. It is influenced by three input values, namely, a value controlling action $Q_{\text{gain}}(t)$, and two perturbing $T_{\text{outdoor}}(t)$ and $G_{\text{fr.air}}(t)$ values. The control action represented by the feed of heat from the heating system with the transfer function $WT_2(p)$ described the transfer function of $WT_1(p)$, and heat loss during operation of the ventilation system for the preparation of fresh outdoor air. The control function was aimed at compensating disturbances in the form of heat loss through the building envelope (with a positive differential indoor $T_{\text{indoor}}(t)$ and the outside temperature $T_{\text{out}}(t)$). The consumption of fresh air $G_{\text{fr.air}}(t)$ was determined by the process of stabilizing loop air quality and its impact on the temperature $T(t)$ as described by the $WT_3(p)$ transfer function.

3. Simulation Results

The numerical simulation results shown in Figures 1-2 include temperature field distribution and relative humidity in the horizontal plane data distance of 1500 mm from the room floor.

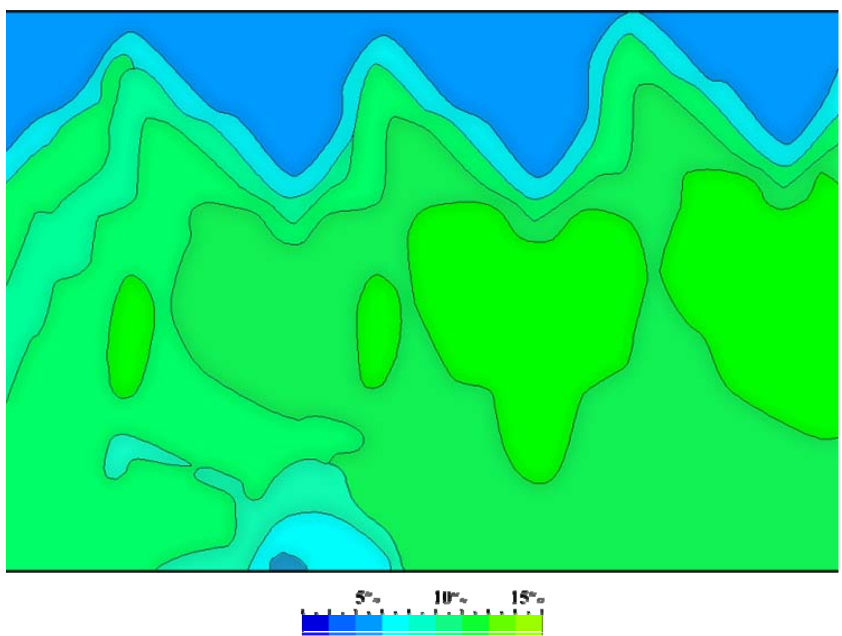

Figure 1. Distribution of relative humidity.

Field temperatures (Figure 2) confirmed the impact of rising convective flow from heating devices, individuals, and PCs. Accordingly, downward flows were also observed near the outer wall.

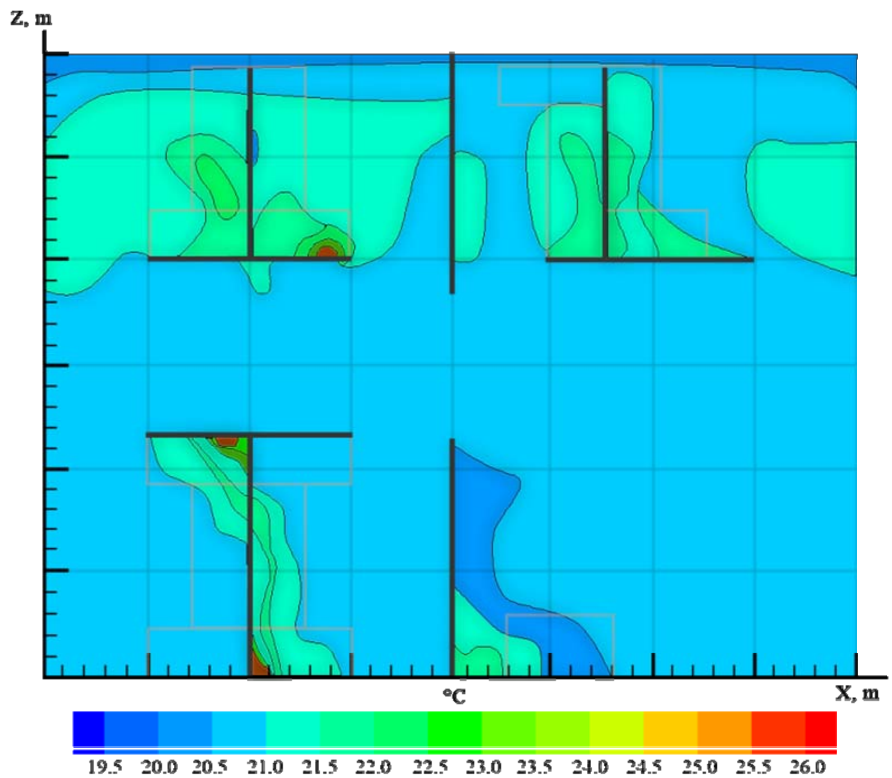

Figure 2. Distribution of air temperature.

4. Conclusion

In the research paper, we explored main parameters that affect to comfort level of indoor microclimate. Also, we explore how to get desired comfort level in gyms, and how to ensure desired temperature and humidity level. In the next research, we will expand our model applying fuzzy logic and neuro-fuzzy models.

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