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ANALYSIS OF EXISTING MODELS FOR MICROCLIMATE MANAGEMENT

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Abstract: To solve practical tasks such as assessing microclimate comfort or determining the required power of systems that provide the microclimate, it is necessary to establish the distribution of microclimate parameters within a room and their variation over time. In this case, process modeling or reproduction using specific methods employed, with the condition that the reproduction should adequately reflect the actual conditions of the processes occurring in nature.
Keywords: microclimate comfort, modeling, methods, model.

I. Introduction

The relevance of the topic of microclimate control and management in office and educational spaces connected to the problem of creating comfortable or optimal working and learning conditions. Given that there is insufficient attention to this issue in the literature or the focus is mainly on microclimate control and management in agricultural facilities, creating comfortable conditions for people remains a significant task for maintaining health [1]. The types of mathematical modeling used pursue research or computational goals [2].

For modeling the processes of microclimate formation, three types of modeling are usually applied:

– **Mathematical modeling** based on solving a system of differential or algebraic equations that describe the thermal, air, humidity, and gas conditions of the room.

– **Physical modeling** in natural conditions or on geometrically similar models, where physical processes are transferred using scale relationships;

– **Analog modeling** – a type of physical modeling, where real processes replaced by others that have a formally analogous mathematical description [2].

II. Mathematical Model of the Room Microclimate

The mathematical model of the microclimate in educational rooms can be written as a function that depends on a range of parameters that change over time.

$$\dot{x} = f(T, \mu, \varsigma, K, \mathrm{C}, \mathrm{V}, \tau)$$

where T - the temperature in the room; μ - the air humidity; ς - the air purity; K - the freshness of the air; C - the CO_2 concentration; V- the room volume; τ - time.

The mathematical model of the microclimate, as considered in the literature [3-4], has several specific features. For example, in some sources [5-8], mathematical models of rooms based on heat and mass exchange are discussed, but without considering air purity and freshness.

Let us consider the parameters of the microclimate individually. The air temperature in the room, with a certain relative humidity, at which the effect of thermal sensation and heat transfer will be the same. It is assumed that the air is stationary [9], and the index of effective temperature is used.

$$E_T = T - 0{,}4(T - 10)(1 - \frac{\mu}{100})$$

where μ — the daily average relative humidity of the air, %; T — the daily average air temperature, °C.

Air purity implies that the air should not contain dust, allergens, volatile compounds, smoke, or biological contaminants. Polluted air leads to breathing problems, allergic reactions, and other negative health consequences, including cancer [7].

Air freshness and carbon dioxide (CO_2) concentration are interconnected. Freshness is determined by the amount and ratio of oxygen to carbon dioxide (CO_2) in the air. This indicator is crucial for analyzing the microclimate [8]. The CO_2 concentration should not exceed 8000-10000 ppm.

Using physical modeling methods, physical processes can be presented in a simplified, idealized form. Physical modeling is carried out in natural conditions and on geometrically similar models, in particular, natural studies in this work are carried out on existing objects. For this purpose, robotic elements used to create a microclimate control system with long-term observations of the object [2]. In this work, mathematical modeling is associated with physical modeling in conditions of changing parameters of objects, depending on the season and time of year. Since the creation of a microclimate control system in educational premises plays an important role, the creation of a mathematical model began with the analysis and determination of the main input, control and disturbing parameters. Among these parameters, the following parameters identified that characterize the state of the air [7-11].

In thermal similarity, the similarity of temperature and heat flows is maintained [8].

The conditions for uniqueness, which must be reproduced in the model, include:

- The geometric shape of the modeled room;
- The location and shape of the air supply and exhaust openings in the room;
- The velocity and temperature of air at the supply and exhaust openings;
- The physical parameters of the air (density, viscosity, specific heat, thermal conductivity);
- The sources and sinks of heat, moisture, vapors, and gases (location and shape, temperature and concentration, power).

The main criteria for mechanical similarity are [6-11]:

- **Reynolds (Re)**, which determines the ratio between inertial forces and viscous forces;
- **Froude (Fr)**, which expresses the ratio between gravitational and inertial forces;
- **Archimedes (Ar)**, which characterizes the ratio between inertial and buoyant forces;
- **Euler (Eu)**, which defines the relationship between pressure forces and dynamic forces.

Thermal similarity is determined by the following criteria:

- **Prandtl (Pr)**, which characterizes the physical properties of air;
- **Péclet (Pe)**, similar to the Reynolds number;
- **Nusselt (Nu)**, which characterizes the heat transfer process at the boundary between a solid body and a fluid.

In classrooms, which are part of multi-story educational buildings, complex heat and mass exchange processes occur, and when calculating mathematical models of these, it is important to take into account the specified coefficients and parameters. In this case, models with distributed and concentrated parameters are distinguished. For this purpose, high-precision sensors of temperature fluctuations, humidity, and pressure used in the work, installed at different points in the room and building [12].

III. Conclusion

In the course of the scientific work, known mathematical models of the microclimate of educational premises analyzed and the main problematic tasks and issues identified. When creating a mathematical model of an educational premises, it is important to take into account a number of parameters and boundary conditions.

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