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THE ROLE OF AIR HUMIDITY IN THE LIFE OF LIVING ORGANISMS

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Abstract
Air humidity is one of the most important ecological and biophysical factors, determining the intensity of heat exchange, evaporation, respiration, and water balance in living organisms. This article examines the physical parameters of humidity and their effects on the physiological processes of humans, animals, and plants. The biophysical mechanisms of humidity influence are highlighted, including the role of water vapor partial pressure, saturation deficit, and the equilibrium between evaporation and heat dissipation. The main consequences of both low and high humidity levels are presented, as well as their significance for the vitality and functioning of living organisms.

Keywords: Air humidity; biophysics; partial pressure; evaporation; heat exchange; transpiration; dehydration; ecology; water balance; living organisms.

Introduction

Air is an indispensable part of human life and one of its essential sources. Humans cannot survive without air. Atmospheric air is a mixture of various gases and water vapor. Alongside temperature and atmospheric pressure, the amount of water vapor in the air plays a crucial role for human health. Relative air humidity is an important ecological indicator of the environment. Humidity affects the rate

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of moisture evaporation from the surface of human skin, which is essential for thermoregulation. Extremely low or high humidity levels can lead to rapid fatigue, reduced perception, and impaired memory.

Humidity influences not only humans directly but also the surrounding environment. The preservation of artworks and books requires maintaining air humidity at a specific level, which is why psychrometers (devices for measuring humidity) are commonly found in museums. Food products, construction materials, and many electronic devices must also be stored within a strictly defined range of relative humidity. Numerous technological processes are feasible only under precise control of water vapor content in the air of production facilities. Although the amount of water vapor in the atmosphere is relatively small, its role in atmospheric phenomena is significant. Condensation of water vapor leads to cloud formation and subsequent precipitation, which contributes to the regulation of climatic conditions in regions that are far apart. Knowledge of humidity is also crucial in meteorology for accurate weather forecasting.

In dry air with low relative humidity, evaporation—and the associated cooling—occurs rapidly. In air with high relative humidity, evaporation slows down, and cooling is minimal. Thus, humidity plays a key role in both biological processes and environmental systems.

Thus, humidity plays a significant role in human life. It is therefore very important to monitor air humidity and be able to measure it accurately. Air humidity is one of the key parameters of the indoor microclimate, which is why we became particularly interested in the problem of determining air humidity in school classrooms.

During the academic year, students spend a significant portion of their time in university classrooms. In this regard, it is necessary to determine whether the conditions in these educational spaces comply with current sanitary and hygienic standards.

This leads to the formation of the research problem: does the relative humidity in classrooms meet sanitary requirements and provide optimal conditions for the health and productivity of students?

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Based on this problem, we formulated the research topic: **"Air Humidity and Its Influence on the Vitality and Performance of Students in University Classrooms."**

Research Aim.
The aim of this study is to investigate air humidity in various rooms of the university building and to identify deviations from the permissible standards.

Research Objectives
To achieve this aim, the following tasks were set:
- Define the key concepts related to air humidity;
- Describe the main methods for measuring air humidity;
- Determine the effects of air humidity on the human body, as well as on equipment, technology, and other objects present in the rooms;
- Identify optimal humidity levels under different conditions;
- Measure air humidity in various rooms of the university building, compare the obtained data with sanitary standards, and draw appropriate conclusions.

Object of Study
The study focuses on the university classrooms.

Subject of Study
The study examines the temperature regime and the percentage of moisture in the rooms.

Methods.
Comparative, statistical, logical, systems approach, and analytical methods were used.

Equipment.
A psychrometer and a psychrometric table were employed for measurements.

Hypothesis.
The relative humidity in university classrooms meets the established standards, and therefore has a positive effect on human health and performance.

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Practical Significance.

The results of this study can be used to improve the microclimate of the university, as students and teachers spend the majority of their time in these educational spaces.

Relevance of the Study.

The relevance of this research is highlighted by the recent increase in respiratory illnesses among school and university students. Low humidity leads to rapid evaporation and drying of the mucous membranes of the nose, throat, and lungs, increasing the risk of colds and other diseases. Conversely, high humidity can also have negative effects on the human body, disrupting heat exchange with the environment, which may result in overheating.

Chapter 1. Main Characteristics of Air Humidity

1.1 Concept of Air Humidity

The quantity that characterizes the content of water vapor in different parts of the Earth's atmosphere is called **air humidity**. The degree of air humidity has a significant impact on many processes occurring on Earth. Measurement and control of humidity have considerable practical importance.

For quantitative assessment, **absolute** and **relative humidity** are distinguished in practice.

Absolute air humidity refers to the mass of water vapor contained in a unit volume of air.

$$l = \frac{m}{V} \qquad [l] = 1 kg/m^3$$

Atmospheric air is a mixture of various gases and water vapor. Each gas contributes to the total pressure exerted by the air on bodies within it.

The **partial pressure of water vapor** is the pressure that water vapor would exert if all other gases were absent. However, the partial pressure alone does not indicate how close the water vapor is to saturation under given conditions.

Therefore, in science and engineering, the degree of air humidity is usually expressed as **relative humidity**: the ratio of the partial pressure (ppp) of water

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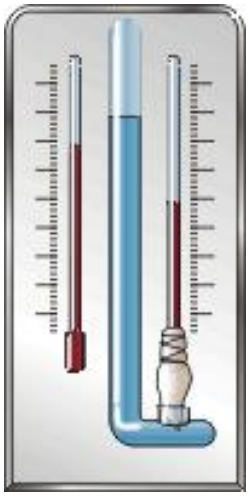


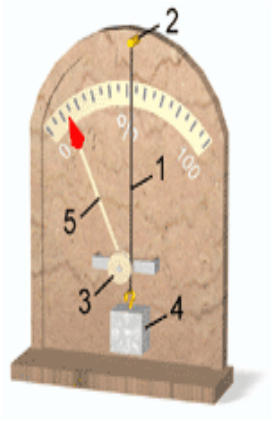
vapor contained in the air at a given temperature to the pressure of saturated vapor (p0p_0p0) at the same temperature, expressed as a percentage.

Relative humidity indicates how much more moisture is needed for condensation to occur under the given environmental conditions. This parameter characterizes the degree of saturation of air with water vapor.

1.2 Measurement of Air Humidity

There are several instruments used to measure air humidity.

The simplest device for measuring air humidity is the **hair hygrometer**. A degreased human hair serves as the humidity-sensitive element [1]. The hair is fixed at the top of the device [2], wound around a roller [3], and tensioned using a specially selected weight [4]. A pointer is attached to the roller [5]. As the relative humidity of the air increases, the hair elongates, causing the roller and pointer to move. The pointer moves along a scale and indicates the air humidity as a percentage.



The **condensation hygrometer** is used to determine the **dew point** — the temperature to which air must be cooled so that the water vapor it contains becomes saturated upon cooling.

Another instrument for measuring air humidity and temperature is the **psychrometer**.

The **psychrometer** consists of two thermometers. The bulb of one thermometer remains dry and measures the air temperature. The bulb of the other thermometer is wrapped with a strip of cloth, the end of which is immersed in water. As the water evaporates, the thermometer cools. The higher the relative humidity, the less intense the evaporation, and the smaller the difference between the readings of the two thermometers. When the relative humidity reaches 100%, no evaporation occurs, and both thermometers show the same temperature.

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By measuring the temperature difference between the two thermometers and using special **psychrometric tables**, the relative humidity of the air can be determined. Psychrometers are typically used in situations where a sufficiently accurate and rapid measurement of air humidity is required.

1.3 Consideration of Air Humidity

Water enters the human body daily through liquids, food, and via the skin and mucous membranes of the respiratory tract in air enriched with moisture. There are a number of health issues associated with the disruption of water balance in the skin and mucous membranes. Low humidity accelerates the aging process of the skin, causing it to lose firmness and elasticity, which can lead to skin diseases (e.g., dermatitis) and affect the metabolism of the entire body.

Consequences of excessive dryness of air include:

- **Fatigue:** Dry air hinders the intake of oxygen, leading to poor well-being, tiredness, lack of concentration, and increased strain on the heart.
- **Diseases of mucous membranes:** The mucous membranes of the upper respiratory tract lose their protective function.
- **Increased risk of bacterial infection of the eyes:** The protective function of the ocular mucosa is compromised. This is particularly dangerous for contact lens wearers, as accelerated drying of the lenses causes discomfort and additional irritation of the eyes.
- For a healthy person not suffering from respiratory infections, the optimal relative humidity of air should be at least 50%. When humidity decreases, the mucous membranes of the respiratory tract dry out, which can lead to nasal congestion and impaired breathing. In addition, dryness promotes the accumulation of viscous mucus in the nasal and respiratory cavities, creating a favorable environment for bacterial growth and increasing the risk of infections.
- **Dry skin:** Low air humidity accelerates the evaporation of water from the skin, making it dry, rough, prone to inflammation, and prone to peeling. The main symptom of pronounced skin dryness is **itching**. Maintaining normal air humidity reduces the risk of respiratory diseases.

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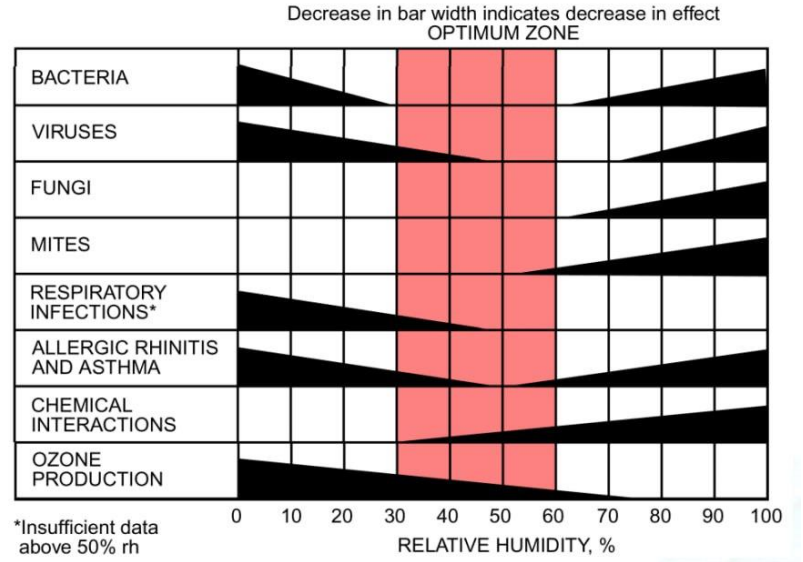
- **Dust:** Optimal air humidity helps "bind" dust particles, which is particularly important for people suffering from asthma and allergies.
- People generally feel better in humid air. Various methods can help prevent excessive moisture loss from the skin, including moisturizing cosmetics, wearing cotton clothing, and water-based treatments.
- Both low and high humidity levels can create favorable conditions for the growth of bacteria, fungi, and viruses.



[2]2016 ASHRAE HVAC Systems and Equipment Handbook – Ch 22

However, one of the most important conditions for maintaining normal water balance in the body is a proper air humidity and temperature regime in indoor spaces. The optimal conditions for humans are a relative air humidity of **45–55%** at a temperature of **18–24°C**. Humidity affects not only our physical health but also our psychological state. In some rooms, people may feel uncomfortable without understanding the exact reason, even though, on average, a person spends more than 20 hours per day indoors.

Since part of the heat from the human body is released as water vapor, the air must have a certain capacity to absorb this moisture. The average amount of water vapor released by a person is approximately **900 g per day**, with about **300 g** through the lungs and **600 g** through the skin.

Excessive air humidity leads to increased sweating and fatigue: breathing becomes faster, more moisture is absorbed through the lungs, and more is lost as

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sweat. Combined with high temperatures, high humidity can cause **overheating of the body**, a situation typical during hot summer months.

On the other hand, low humidity causes the skin to become dry, rough, and prone to cracking. Extremely dry air is common in heated indoor spaces during winter, with the lower limit of humidity reaching around **20%**.

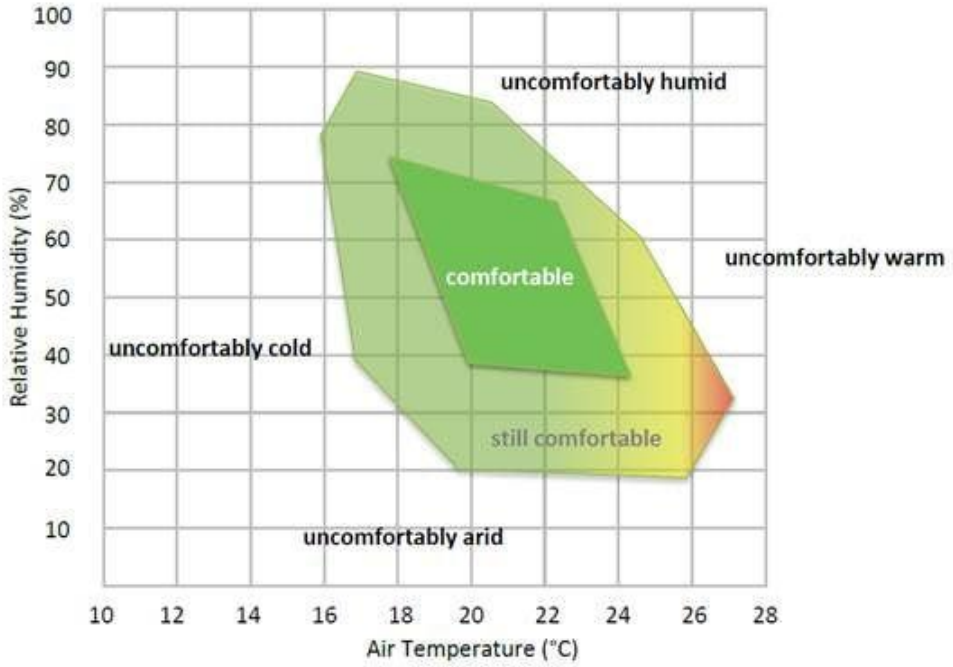

Figure: Comfort Zone Representing Optimal Temperature and Relative Humidity

Numerous scientific studies have shown that the **comfort zone**—that is, the range of environmental conditions in which a healthy person does not feel hot, cold, or stuffy and feels most comfortable—is not standard for all people, different climatic regions, or all seasons. It depends on lifestyle, age, and socio-economic conditions.

Air movement has a significant impact on the indoor environment, affecting the distribution of temperature and humidity within the space, the presence of stagnant zones, and so on. The effect of air movement on human comfort must be considered together with the temperature and relative humidity of the room.

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1.4 Signs Indicating Insufficient Air Humidity

Insufficient air humidity in a room can often be judged by observing indoor plants. Most plants are adapted to higher humidity than that found in typical indoor environments. They suffer from a lack of moisture in the air more frequently than from excess. In dry air, plants evaporate more water through the stomata in their leaves, disrupting their water balance:

- **Leaves curl or become wrinkled**.
- **Leaf tips turn brown and dry out**. This is commonly observed in plants such as **Ficus benjamina**, **Nephrolepis**, and **Cyperus**.
- **Young leaves do not develop fully**.
- **Buds fail to open or fall off**.
- Certain pests are more likely to attack plants in excessively dry air, particularly **spider mites** and **thrips**.

Conclusions

Air humidity is a fundamental biophysical factor that influences the vitality and functioning of all living organisms. By affecting the partial pressure of water vapor and the rate of evaporation, humidity regulates heat exchange, respiration, water balance, and a wide range of physiological processes in the body. Low humidity leads to accelerated water loss, dehydration of mucous membranes, reduced immune defense, and deterioration of well-being. In contrast, high humidity limits heat dissipation, increases the risk of overheating, promotes the growth of microorganisms, and reduces indoor air quality.

Optimal relative humidity is especially important in educational institutions, where students and teachers spend a significant portion of their time. Failure to maintain proper standards can result in increased fatigue, decreased productivity, and impaired cognitive function.

Understanding the role of humidity is essential for medicine, ecology, agriculture, and the creation of comfortable living conditions. Regular monitoring of indoor humidity, the use of ventilation systems, and maintenance of an optimal microclimate contribute to the preservation of health, enhanced learning efficiency, and improved quality of life.

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