Buildings and Environment

Metodický koncept k efektivní podpoře klíčových odborných kompetencí s využitím cizího jazyka ATCZ62 - CLIL jako výuková strategie na vysoké škole

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Abstract

- The aim of the course is to introduce the theory of indoor environment in order to respect the laws of the environment of buildings. Basic knowledge of selected pollutants is presented in relation to their characteristics, sources and potential occurrence in the indoor environment of buildings. Emphasis is placed on understanding the context of selected building structures and systems of technical equipment of buildings. The assumed output is the ability to evaluate and optimize the individual components of the physical, chemical and biological aspect of interest in the context of well-being, health and safety of indoor environment.

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Topics

1. Buildings and Environment
2. Temperature and Humidity in the Indoor Environment
3. Acoustic Microclimate – Building noise
4. Ionization microclimate
5. Radon in the Interior of Buildings
6. Toxic microclimate
7. Aerosols in the Internal Environment of Buildings
8. Odors in the Interior od Building
9. Microorganisms in Indoor Climate
10. Electrostatic and Electromagnetic Energy in Buildings
11. Electro-ionic Microclimate
12. Psychic and Light Microclimate

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1. Buildings and Environment

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Indoor Environment

- **The indoor environment** is an environment without direct connection to the outdoor environment.

- The indoor environment of buildings can be divided into:
  - **Residential environment**
  - **Work environment**
  - **Civic amenities**
  - **Other premises** (Vehicles and other constructions, ...)

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Sick Building Syndrome

- In 1983, WHO defined these health problems such as Sick Building Syndrome (SBS). Today, it is already almost 85 %.
- **Sick Building Syndrome can be described as a group of more or less serious diseases and health problems that occur during a long stay in closed rooms. Common symptoms are:**
  - **Development of allergies**
  - **Asthma, repeated airway inflammation**
  - **Headache, eye irritation**
  - **Increased blood pressure, cholesterol**
  - **Cardiovascular diseases**
  - **Depression, neurosis, impaired immunity ...**

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Factors of the Indoor Environment

- Factors affecting the quality of the indoor environment or the internal microclimate of buildings include:
  - **Physical factors** - temperature, humidity and air circulation, lighting, radiation, electromagnetic field, noise
  - **Chemical factors** - inorganic substances, organic substances and fibrous materials
  - **Biological factors** - bacteria, viruses, mites, molds, pollen, parts of plants, hair dust and domestic animal excrements

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Microclimate

- **Microclimate** is the climate of a very small or restricted area, especially when this differs from the climate of the surrounding area.

- The microclimate depends on the conditions prevailing in the area and its surroundings.

- Components of the indoor air environment of buildings intentionally created for human stay in confined spaces can generally be characterized as **internal (indoor) microclimate**.

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Microclimate

- **Microclimatic parameters are affected:**
  - External climatic conditions and air quality
  - The way of ventilation and heating
  - Heat load due to technology, quantity and activity of people, machines, devices and lighting
  - Thermal-technical properties of the building

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Mass Agens and Energy Agens

- **Agens** are substances of a mass or energy nature acting on the subject:
  - **Mass agens:** toxic gaseous substances, solid aerosol, toxic gases, microbes, toxic liquids, liquid aerosol, odors, air movement, water vapor.
  - **Energy agens:** heat, light, UV radiation, laser radiation, ionizing radiation, ions in the air, static electricity, sound, vibration.
- **Pollutant** is gaseous, liquid or solid chemical, which has a harmful effect on living organisms at certain concentrations and duration of action.

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Components of Indoor Environment

- The **indoor environment** is made up of a variety of different components:
  - Thermal - humidity microclimate
  - Odor microclimate
  - Microbial microclimate
  - Light microclimate
  - Acoustic microclimate
  - Ionization microclimate
  - Aerosol microclimate
  - Toxic microclimate
  - Electrostatic microclimate
  - Electromagnetic microclimate
  - Electro-ionic climate
  - Psychic microclimate

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Sources of Pollution and Pollutants:

- **Outdoor air:** Carbon, nitrogen and sulfur oxides, ozone, solid particles, volatile organic compounds, polycyclic aromatic hydrocarbons, allergens (pollen)
- **Outdoor environment:** Soil gas, water
- **Building:** Formaldehyde, Benzene, Asbestos, Toluene, Solids, Volatile Organic Compounds
- **Electrical devices:** Volatile organic substances
- **Garages:** Carbon oxides, nitrogen oxides, solid particles, volatile organic compounds, polycyclic aromatic hydrocarbons
- **Heating, hot water, cooking:** carbon and nitrogen oxide, solid particles, volatile organic compounds, polycyclic aromatic hydrocarbons
- **Activities in the building:** Volatile organic substances, solid particles
- **People:** Cigarette smoke, solid particles, volatile organic compounds, odors (biofeeds), (micro) biological contamination, allergens

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2. Temperature and Humidity in the Indoor Environment

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Thermal-Humidity Microclimate

- **Thermal-humidity microclima**te is a component of the indoor environment formed by **thermal and humidity flows.**

- From the point of view of health and comfort, the thermal-humidity microclimate ranks among **the most important component of the indoor building environments.**

- Hygrothermal microclimate is defined by three fundamental factors **- indoor air temperature [°C], indoor relative humidity [%] and air velocity [m/s].**

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Thermal-Humidity Microclimate

- The basic values determining the quality of the thermal-humidity microclimate in buildings are:
  - **Indoor air temperature**
  - **Final temperature of spherical thermometer**
  - **Operating temperature,**
  - **Air flow rate**
  - **Relative humidity**
  - **Specific air humidity**
  - **Dew point temperature**

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Thermal-Humidity Microclimate

- **The indoor air temperature [°C]** also dry temperature is the temperature around the human body, measured by any temperature sensor unaffected by the radiation of the surrounding areas.
- **Relative humidity [%]** represents the degree of air saturation by water vapor. It is defined by the ratio of water vapor density in air and humid air saturated with water vapor at the same temperature and pressure.
- **The air flow velocity [m/s]** characterizes the movement of air in the space. It is determined by its size and direction of flow. Because the velocity of airflow varies greatly in the space, it is necessary to express its variation with the mean value per time unit.

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Thermal Comfort

- **Thermal comfort** can be defined as the state of the environment, which in humans causes welfare and meets his feelings.

- Man does not feel cold nor too warm.

- Thermal comfort is a state of balance between the person and indoor environment without the overburdening **thermoregulatory system.**

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Regulation of Thermal Comfort

- Both flows can be regulated in a variety of ways, such as changing activities or clothing.

- Differences between heat produced and heat removed from the body's environment compensate for **thermoregulation mechanisms.**

- **Thermoregulatory processes** are related to age, general health status, nutrition status, motion regime and are directly affected by the thermal and humidity status of the environment.

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Regulation of Thermal Comfort

- **The optimal indoor air temperature should be maintained within the range of 19 - 24 °C** if there is no difference between room temperature and room temperature than 2 °C at an air flow rate of approximately 0.2 m/s.

- In the summer, the negative impact of high temperatures on the human organism must be reduced. The recommended maximum indoor air temperature for the summer season is 26 - 27 ° C.

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Optimal Humidity of Indoor Environment

- In the summer, high relative humidity associated with high temperature can adversely affect the body's thermal balance by limiting respiration and hence loss of heat. There are many sources of moisture in residential buildings.
- **The optimum moisture of the internal environment fluctuates from 30 to 50%.** The humidity in the range from 30 to 70% is still considered as a comfortable indoor environment.
- Humidity of in the indoor environment should not exceed 70% during the summer.
- In winter, the indoor relative humidity should not fall below 30%.

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3. Acoustic Microclimate Building Noise

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Acoustic Microclimate

- **The acoustic microclimate** is an important component of the indoor environment characterized by a large number of sound sources with a wide range of frequencies.

- **Noise is either penetrated from the outside through the building envelope,** or the **noise is generated directly inside the building.**

- From its source, the noise is transmitted either **by air only**, or transmitted **by building structures and then by air.**

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Acoustic Microclimate

- **Acoustics** is a field of physics dealing with the study of sound - the study of the mechanical vibrations and waves in flexible environments, its creation, dissemination and action.

- **Sound** is mechanical waves in a fabric environment that is capable of producing an auditory sensation.

- **Noise** is any unwanted sound that adversely affects the well-being of a person, causes an unpleasant, disturbing feeling, endangering his health.

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Acoustic Microclimate

- In terms of the time course, it is recognized:
  - **Stabilized noise** at a given location does not change over time by more than 5 dB
  - **Variable noise** varies over time by more than 5 dB in time
  - Intermittent noise is noise, which suddenly changes the sound pressure level or the sound level, which is steady during the noisy interval
  - **Pulse noise** is generated by individual sound pulses with a duration of up to 200 ms or a sequence of pulses successive at intervals longer than 10 ms

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Biological Effects of Noise

- The persistent effect of noise on the human organism is of three kinds:
  - **Effect on hearing organs** - Harmfulness of hearing effects depends on sound level and frequency waves. The more energy is concentrated in the higher frequencies, the lower the noise level is
  - **Effect on the vegetative nervous system** - Reactions are dependent on the subjective perception of the individual
  - **Effect on human psyche** - It is the most complex of effects. Neuroscientists may aggravate the nervous system lability, which is manifested by irritability, insomnia, headaches, memory impairment

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Optimization of Acoustic Microclimate

- The optimization of the acoustic microclimate can be done:
  - **Interference to the source of noise**
  - **Intervention in the field of transmission of noise**

- The most effective way to improve acoustic comfort is to **remove or replace the source of noise**. Consideration is also given to organizational measures to **limit major sources or transport** them to **better acoustically isolated places** (covers or dampers).

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Optimization of Acoustic Microclimate

- Optimization of acoustic comfort by intervention in the field of transmission can be done by installing barriers, increasing absorption and decreasing the reflectivity of the walls and ceilings or so called **anti-noise**.

- The **principle of anti-noise** method is based on the principle of the propagation of airborne pressure waves. Anti-noise is a mirror image of these waves but phase shifted precisely by 180 °. Encounters two waves to each other, interference occurs destructive (waves cancel each other out).

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4. Ionization Microclimate

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Ionization Microclimate

- **Ionization microclimate** is a component of indoor environment formed by flows of ionizing radiation produced by radioactive substances of **natural or artificial sources,** which act on the individual and form one's overall condition.

- The basic physical quantity of ionization is the **activity** (Ak) of a given amount of radionuclide expressing the proportion of the mean number of radioactive changes and the time interval. **The unit of activity is one decay per second or Becquerel (Bq).**

- The source of ionizing radiation may be radioactive substances **penetrating into the interior from the external environment,** or substances occurring inside the building due to **anthropogenic activities** and the release of **building materials and technological equipment containing** radioactive material.

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Ionization Microclimate

- **Radioactivity** is the transformation of the core of an element into the core of another element, while releasing large amounts of energy in the form of invisible radiation (so-called radioactive radiation) that is dangerous to humans. There is natural and artificial radioactivity.

- **Radionuclide** is a nuclide with an unstable nucleus whose atoms are subject to radioactive transformation together with the emission of ionizing radiation.

- **Half-life** is the time taken for half the radionuclide's atoms to decay. The half-life is constant for the isotope of the given element. The half-life has values from a fraction of a second to millions of years.

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Optimization of Ionizing Radiation

- Optimization of ionizing radiation can be ensured either by **intervention into the source** of radioactive material, or **interference into the transmission field** of ionizing radiation.
- **Intervention into the source** can be performed by:
  - Selecting a suitable building site (locality)
  - limiting or preventing the penetration of radon into the building (antiradon measures)
  - Choosing suitable building materials (certified materials and products)
- **Interferences into the transmission** involves:
  - Restricting the spread of radioactive substances in the building
  - Ventilation and air filtration
  - Surface deposition, i.e. sedimentation of radioactive substances
  - Electrostatic deposition

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Optimization of Ionizing Radiation

- The limitation of the spread of radioactive substances in the building can be achieved by **design-layout modifications** of the building such as **dividing vertical shafts into smaller sections, appropriately transferring sources of radioactive material in the building, or applying differential ventilation.**
- The spread of ionizing radiation is a problem especially in multi-storey buildings, when the radioactive material is propagated by **thermal buoyancy.**
- Continuous stairs along the height of the building without interruption can be a source of intense spread of radioactive gases throughout the building.

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Optimization of Ionizing Radiation

- In addition to ensuring adequate air exchange, it is advisable to design pressure zones between spaces according to the degree of their contamination (contamination).

- The largest negative pressure is chosen for areas with the highest contamination. Air recirculation is not included in such areas.

- Reducing the dose of fresh air in order to reduce the energy performance of a building can result in an increased concentration of radioactive substances in the building.

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Optimization of Ionizing Radiation

- Filters can reduce the spread of radioactive substances bound to some kind of aerosol. There are two types of filters - cassette or electrostatic:
  - **Cassette filters** are boxes with a filter cartridge. Filter cartridges are not washable, but they are replaced with new ones (low acquisition costs, but higher operating costs)
  - **Electrostatic filters** do not increase overall system pressure over time (like other filters). Captured particles can be washed with water (high cost of ownership, cheap operation).
- **Electrostatic deposition** operates on the principle of artificially created electrostatic field. Electrically charged particles settle on electrodes of opposite polarities.

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5. Radon
in the Interior of Buildings

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Radon

- **Radon** is a ubiquitous natural radioactive gas. **Radon is formed by the decay of uranium**, which is present in various quantities in all Earth's crust materials.
- **Radon is an inert gas.** Its **daughter products** are harmful to health. They are inhaled along with carrier solid and liquid aerosols into the lungs where they settle down. Alpha radiation **irradiated pulmonary epithelium**, there is a potential risk of developing **lung cancer**. This irradiation is considered one of the causes of lung cancer.
- In general, **the higher the concentration and the longer the exposure, the higher the risk.**

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Radon

- **Physical properties of radon:**
  - Boiling point -62 °C
  - Melting point -71 °C
  - Evporation heat 16,40 kJ/mol
  - Melting heat 2,89 kJ/mol
  - Evaporation entropy 77,02 J/deg.mol
  - Melting entropy 14,35 J/deg.mol
  - Critical temperature +104,3 °C
  - Critical pressure 6 322,7 kPa
  - Critical density $1{,}2.10^3$ kg/m

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Radon Sources

- The most important source of radon in buildings is the **subsoil**.
- Radon penetrates into the interiors of buildings through the foundation structure - **leaks in floors or walls of the basement, floors without adequate insulation, shafts, ducts or wells.**
- Inalienable possibility of penetration of radon in the indoor environment is **diffusion through the contact surface substructure and subsoil**.
- **Built-in** materials or **water** can also be a source of radon.

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Radon in the Indoor Environment

- Decree no. 422/2016 on Radiation Protection and Security of a Radioactive Source sets a reference level for natural irradiation inside a building with a living room.

- **The reference level for the volume activity of radon is set at 300 Bq/m³.**

- **The average value of radon in buildings** in the Czech Republic is 118 Bq/m³.

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Anti-radon Measures

- Safety of Radionuclide Source, appropriate building modifications should be made, depending on the amount of exceedance. The necessary background for the projection of these adjustments is so-called **radon diagnostics**, which is a whole set of measurements designed to identify sources and radon entry paths into the house.

- Basic intervention at the source is done by **selecting a suitable place of construction, choosing the suitable building material** and **choosing to prevent the penetration of radon into buildings**.

- As a protection of new and modernized structures against the effects of radon can be used **gas-tight foil under the baseplate** with the dimension of the radon risk area and the use of certified building materials

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6. Toxic Microclimate

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Toxic Microclimate

- Air is a mixture of different gases, of which nitrogen, oxygen, argon and carbon dioxide predominate. These gases make up 99.99% of the atmosphere.

- In addition, air contains various dopants such as ozone, carbon monoxide CO, sulfur oxides, ammonia and dust.

- Toxic substances present in the internal environment will be originated either from the exterior or in the interior itself.

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Carbon Monoxide

- **Carbon monoxide** is the product of incomplete combustion for oxygen access.
- The sources include solid fuel stoves, gas appliances without exhaust, fireplaces, non-fired kitchens with a gas stove, and others.
- Smoking of tobacco is also a significant source.
- Carbon monoxide binds to the red blood dye and thus reduces the amount of oxygen transmitted by the blood. **Lighter poisoning** is manifested by headaches, pounding blood in the head, chest pressure, dizziness.

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Nitrogen Oxides

- The sources of **nitrogen oxides** are emissions from automobile transport and from stationary sources burning fossil fuels at high temperatures.

- Eight nitrogen oxides can be found in the indoor environment. Only two cause health damage.

- **Nitrogen dioxide** (NO_2) and **nitrous oxide** (NO) have a harmful effect on humans

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Smog

- **Smog** is the chemical pollution of the atmosphere caused by human activity.

- The atmosphere is enriched with ingredients that are not normally in it and which are harmful to health during a phenomenon.

- Smog (smoke and fog produced by nitrogen oxides) arises because of air pollution, which is degraded by exposure to ultraviolet radiation to other toxic substances, such as ozone.

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Ozone

- **Ozone (O_3 or triatomic oxygen)** is natural gas, which binds to the oxidized organic compounds. It is a reaction with other elements in the atmosphere. Ozone concentrations in the indoor environment tend to be half that of the external environment. There are two types:

  - **Atmospheric ozone**, which is in the atmospheric layer and protects us from harmful ultraviolet rays. Its loss causes the so-called ozone hole.

  - **Tropospheric ozone**, which is contained in the ground air zone and at high concentrations, is harmful to humans.

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Volatile Organic Compounds (VOCs)

- **Volatile Organic Compounds (VOCs)** are defined as organic substances in the solid, liquid or gaseous state that, at normal temperature and pressure, enter the atmosphere in the form of vapor with a pressure greater than 0.13 kPa.

- Their sources include, in particular, adhesives, solvents, paints, coatings, and the like.

- VOCs include for example toluene, xylene, styrene, ethylbenzene, chlorinated hydrocarbons, phthalates and terpenes.

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Polycyclic aromatic hydrocarbons (PAHs)

- **Polycyclic aromatic hydrocarbons (PAHs)** represent a group of more than 100 chemical compounds.
- Polycyclic aromatic hydrocarbons form carbon and hydrogen, two or more benzene nuclei. They
- Their characteristics include **toxic, carcinogenic and mutagenic properties**.
- They have a strong ability to bind to solid sorbents or particles (dust) even in living organisms (bioaccumulation capacity).

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7. Aerosols
in the Internal Environment

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Aerosols microclimate

- **Aerosol microclimate** is a component of an internal environment formed by aerosol flows that co-create the overall state of the internal environment.

- **Aerosol** is a special type of dispersion system consisting of a gaseous phase and solid or liquid particles dispersed therein.

- Aerosols are made up of solid particles (dust) or liquid particles (fog). Solid aerosol are electrically charged positive or negative, with a size of 0.1 to 100 micrometers. In the outdoor air of the city, dust falls within the range of 1100 t/km^2 per year at a standard concentration of 1 to 3 mg/m^3.

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Distribution of Aerosols

- Aerosols can be divided into **solid aerosols** and **liquid aerosols**.

- Solid aerosols or dust can be classified according to their origin by **organic** (animal or plant origin), **inorganic** (metallic or non-metallic) and **mixed.**

- The process of sedimentation of dust particles is influenced by the earth's attraction, air resistance and the electrical polarity of individual material surfaces. Aerosol particles are microbial transporters.

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Distribution of Aerosols

- According to the shape of the dispersed particles can be divided aerosols **corpuscular, laminar, and fibrillar disperse systems**:
  - **Corpuscular dispersion systems** consist of isometric dispersion particles whose dimensions are approximately the same in all three spatial directions.
  - **Laminar dispersion systems** (mineral particles of bentonite and kaolin) and **fibrillary dispersion systems** (natural and synthetic fibers of inorganic or organic nature) have anisometric particles. One or two of these dimensions predominate in such particles and belong to di-form systems.

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Biological Effects of Aerosols

- The effect of an aerosol microclimate depends primarily on the flow of aerosol particles, the exposure time, the concentration, the chemical composition and the physical properties.
- Physical characteristics include **particle size, shape and strength, electrical charge, solubility in biological fluids, and others.**
- Aerosols act mechanically on the skin, in the conjunctival sac, on the mucosa, block the lymphatic pathways in the lungs and the like. Longer exposure is irritating and results in nonspecific inflammatory changes of the skin, conjunctiva and mucous membranes depending on the chemical composition of the particles, their amount, size, shape, depth of action and individual response.

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Optimization of Aerosol Microclimate

- **Intervention to the** source of aerosols can be done in three basic ways:
  - Change of technology already in preparation for operation
  - Mixing bulk material with other suitable substances, such as water
  - Closing the source with a solid cover or liquid screen

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Optimization of Aerosol Microclimate

- **Interference with the aerosol transfer field** can be accomplished:
  - Limiting aerosol dispersion in the building (vertical or horizontal distribution)
  - Ventilation
  - Air filtration through filters in air handling units
  - Coagulation of aerosol particles (by spraying a liquid aerosol with high wettability, small particles are merged into larger ones that settle down due to gravity)

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8. Odors
in the Interior of Buildings

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Odor Microclimate

- Odorous substances are gaseous air components, perceived as **odors**. These are inorganic or organic substances mostly produced by humans or their activities.
- There are five basic types of oder:
  - **Eternal odor** (Human Odors)
  - **Aromatic odor** (ripe fruit)
  - **Isovaleric odor** (smoke from tobacco smoke and animal sweat)
  - **Dusty odor** (dairy products)
  - **Narcotic odor** (degrading proteins)

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Odor Microclimate

- **Odor** is a parameter that is difficult to quantify physically or chemically. It is the ability of odorous substances (odereants) or mixtures of substances to activate the sense of smell and to create sensation.
- **Odorants** are organic or inorganic substances produced by humans themselves and their activities. The dominant constituents of odorous substances in the interior of buildings are carbon dioxide and volatile organic compounds.
- **Olfakometry** is a method of objectively determining odorous substances in the air based on human olfactory senses.

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Odor Microclimate

- Odorous substances enter the interior **from the outside** or they are **generated in an indoor environment** (anthropogenic activities released from building materials).
- Approximately 50-80% of the odors enter the building from outside air.
- These are combustion engine products, production processes, and combustion gases from heat plants.
- As a result of **human activities, various odors such as cigarette smoke, odors of cosmetics, smell of garbage and detergents are emitted.**

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Odor Microclimate

- **The effects of the odorous substances** can be divided into 4 groups:
  - **Refreshing or reassuring**
  - **Positively encouraging**
  - **Atrophied or possibly intoxicating**
  - **Involuntary states of nervous upheaval and aggression**

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Optimization of Odor Microclimate

- The optimal odor climate can be provided by **interfering with the source** of the odor or by **interfering with the field of transmission** from the source to the exposed subject.

- he most effective way to optimize is to **reduce or completely eliminate the odor source**, for example by using fast-drying colors.

- The optimization of the odor microclimate by interfering with the transmission field can be achieved **by limiting the spread of oders in the building, by sufficient ventilation, air filtration, deodorization** or **neutralization with ionized ozone**.

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Optimization of Odor Microclimate

- Filtration of odors is carried out using **filters with activated carbon or charcoal**, by washing with water, by air, by biological washing machine or by biological filter.

- The **Biological washing machine** works on the principle that odor gases are absorbed in scrubbing liquid with dispersed microorganisms. This filtration method is particularly suitable for heavily polluted gases.

- **Deodorization** is based on the use of a different, stronger, but pleasant odor (fragrance) than the original odor.

- The odors can also be eliminated by **intensive ionization of air** with high concentrations of negative aeroionics.

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9. Microorganisms in Indoor Microclimate

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Microbial Microclimate

- **Microbial microclimate** is made up of microorganisms - bacteria, viruses and molds occurring in the interior of buildings. A serious problem is especially spores, fungi and pollen particles, which can trigger allergic reactions.

- **Bacteria** are microscopic single-celled microorganisms of various sizes. The average bacterial size is about 0.3 - 2.0 µm. Some aquatic bacteria have a size of several tens to hundreds of micrometers.

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Microbial Microclimate

- **Viruses** are non-cellular microorganisms of genomic nucleic acid encapsulated by a protein coat, which can only reproduce inside a host cell.
- **Mites** are a number of small arthropods from the class of arachnids whose bodies have merged into a single whole. Many mites are parasitic and dangerous carriers of disease.
- **Fungi** (mold, fibrous microscopic fungi, micromycetes) are multicellular microorganisms. Molds grow in the form of multicellular thread-like structures called hyphae. Fungi that exist as single cells are called yeasts.

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Microbial Microclimate

- **According to the method of entry into the interior** are three sources of microorganisms:
  - Outdoor air as a source of microorganisms
  - Air-conditioning equipment of buildings as a source of micro-organisms
  - Human as a source of microorganisms

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Microbial Microclimate

- The highest incidence of microorganisms in the indoor environment is in the winter.
- Most microorganisms for their life and reproduction urgently needs **high humidity and temperature.**
- Building and technical objects are not the optimal environment for microbes, yet many families of microbes appear.
- These microbes need an extraordinary environment for their lives. They are among the so-called **extrémophiles.**

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Microbial Microclimate

- Selected species of extremophile organisms, including their environmental occurrence:
- **Thermophiles -** High temperatures
- **Psychophiles** - Low temperature
- **Adidophils** - Acidic environment (low pH)
- **Alkalophores** - Essential environment (high pH)
- **Halophyll** - High salt concentration
- **Barophiles** - High pressure
- **Oligophils** - Low concentration of organic substrate
- **Osmophiles** - Water unavailability

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Optimization of Microbial Microclimate

- The quality of the **microbial microclimate** is evaluated according to the acceptable concentration of microbes - for residential environments is max. 200 to 500 microbes/m^3, in the urban environment there are concentrations of up to 1500 microbes/m^3.

- Environmental quality requirements for conventional buildings are met, if bacterial or mold concentration do not exceed of 500 KTJ/m^3 of air (colony forming units).

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10. Electrostatic and Electromagnetic Energy in the Buildings

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Electrostatic microclimate

- **Static electricity** refers to phenomena caused by the accumulation of electrical charge on the surface of various bodies and objects and their replacement in contact with one another.

- **Static charge** is created when two materials met and is separated again, or friction. This causes the distribution or transfer of negative electrons from one atom to another. The size of the charge depends on a number of factors, such as material, temperature, humidity, pressure and material separation rate.

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Sources of Static Electricity

- **Internal sources:**
  - Low air humidity
  - Insufficient grounding of the building / floors
  - All metals
  - Water flow in the heating system piping
  - Electrical wiring
  - All electrical appliances
  - Fire and others

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Sources of Static Electricity

- **External sources:**
  - Building location (crossing of static zones)
  - Wind
  - Building size and building mass
  - Effects of static electricity
  - Infringement of electronics
  - Increased tension on brain cells
  - Unpleasant shocks
  - In healthcare and in industry (material behavior)

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Electromagnetic Microclimate

- **An electromagnetic microclimate** is a component of an internal environment created by an electromagnetic alternating field of electromagnetic waves with a wavelength greater than 1 mm (3.1011 Hz) in the space considered and affecting the overall state of the human. Magnetic induction should not exceed 25 nanotesla, ie 0.025 μT (microtesla) in areas designed for frequent people and sleep.
- Electromagnetic radiation occurs both in the wild and in the indoor environment.
- **Electromagnetic radiation** can penetrate the interior from the outside, or it can be produced by internal sources. In the exterior, atmospheric discharge and solar activity are the natural source of electromagnetic radiation. **Artificial sources** are transmitters and high voltage lines.

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Electrosmog

- **Electrosmog** is all the invisible radiation emitted by household electrical appliances. Depending on the frequency, the electrosmog is divided into low-frequency and high-frequency.

- Electromagnetic radiation affects both living organisms and non-living objects. The most sensitive parts include eyes, nervous systems and sexual organs. Non-living objects are endangered if they are not shielded enough.

- **Electromagnetic compatibility** (EMC) is a scientific field dedicated to protecting users from electromagnetic radiation. Its application is not only in specialized workplaces but also in all areas where people come into contact with electromagnetic radiation.

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Criteria of Electromagnetic Microclimate

- The basic criterion is **irradiation**, which is dependent on **field strength and exposure time**.

- The field strength depends on the distance from the source and its size.

- Optimization of electromagnetic microclimate can be done by intervention to the sources of electromagnetic radiation, or by intervention in the field of transmission or by use of personal protective equipment.

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11. Electro-Ionic Microclimate

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Electro-Ionic Microclimate

- **Electro-ionic microclimate** is a component of the internal environment created by **positive and negative ions** in the atmosphere that act on humans and shape their overall state.

- **Ion** is an electrically charged particle that originates from an electrically neutral atom or molecule by adding or removing electrons while retaining the original number of protons.

- **Aeroion** is a complex of 10 to 30 molecules that is formed by joining electrically charged particles with neutral atoms.

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Sources of Ionization Energy

- The ions are formed by the **action of an electric field, ionizing and ultraviolet radiation**, and so called **Lenard effect**.

- The **Lenard effect** (Also called spray electrification, waterfall effect) occurs when water is sprayed into the air or cracked gas bubbles on the water surface, creating positive and negative ions by separating small particles from the water surface. The whole fluid is therefore divided into small negative particles and larger positive drops.

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Effects of Ions on Human Organism

- **Aeroions** primarily serve to accelerate biochemical reactions. Small or even negative ions are positive for the organism.

- **Negative ions** (anions) in the body to cause an increase in blood pH, decrease blood pressure, decrease in oxygen consumption, increas metabolism of water soluble vitamins, increase of mucosal secretory activity and increase resistance to viral diseases.

- **Positive ions** (cations) cause a decrease in blood pH, increase in blood pressure, decrease in cholesterol levels, drying of mucous membranes.

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Optimization of Electro-Ionic Microclimate

- Optimization of electro-ionic moicroclimate can be done either **intervention to the source** or **intervention in the transmission field.**

- Occurrence aeroins significantly influences and used building materials and surface finish.
- One way to prevent aeroion destruction is to limit transmission activities.

- The second option is to install aerosone ionizers. For practical use, hydrodynamic, corona discharge and ceiling electrode ionizers are currently being manufactured.

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12. Psychic and Light Microclimate

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Colors of the Internal Environment

- **The color of the indoor environment** can be expressed by:
  - Surface color and light color
  - Surface material
  - Combination of colors on multicolored surfaces
  - Size of spaces

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Indoor Lighting

- Lighting can be divided in term of light sources:
  - **Daylight** - natural, scattered light and direct sunlight
  - **Artificial lighting** - artificial sources
  - **Combined lighting** - Daylight illumination supplemented with artificial light

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Indoor Lighting

- The criteria used to describe the light microclimate are:
  - **Daylight factor**
  - **Illumination**
  - **Temperature of chromaticity**
  - **Color rendering index (CRI)**
  - **Glare index**

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Indoor Lighting

- The **light** is a visible glow capable of inducing an immediate visual perception evaluated by normal human sight. The range of visible radiation is within the wavelength range from 380 to 780 nm.

- **The daylighting factor** is the ratio of illumination at a point on a defined plane by a direct or reflected skylight at that time to a comparative illumination of the outer, unshaded horizontal plane under the assumed or known distribution of sky brightness.

- **Light intensity (illumination)** is a photometric quantity defined as the light flux incident to the surface unit. It is therefore the ratio of light flux (lumens) and area (m^2).

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Color of the Space

- **Visual perception** of colors creates feelings of warmth and cold.

- **Color** is the property of light, or the substance from which the light comes out. Color expresses a perception that is created on the retina by visible electromagnetic radiation (waves).

- **The color perception** depends on the spectral composition of the incoming light (dependence of light flux and frequency or wavelength) and its intensity relative to the background.

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Effects of Psychic and Light Stress

- **Visual perception** of the internal space is closely related to the **central nervous system.**
- Light microclimate encourages feelings of anger, excitement, or joy and serenity.
- The light microclimate is defined by the **geometric dimensions of the space, the type of light sources, the number and layout of the luminaires, the uniformity of lighting, the color rendering and the contrast in space.**
- Mental fatigue can be a consequence of all components of the environment on the **human nervous system**.

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