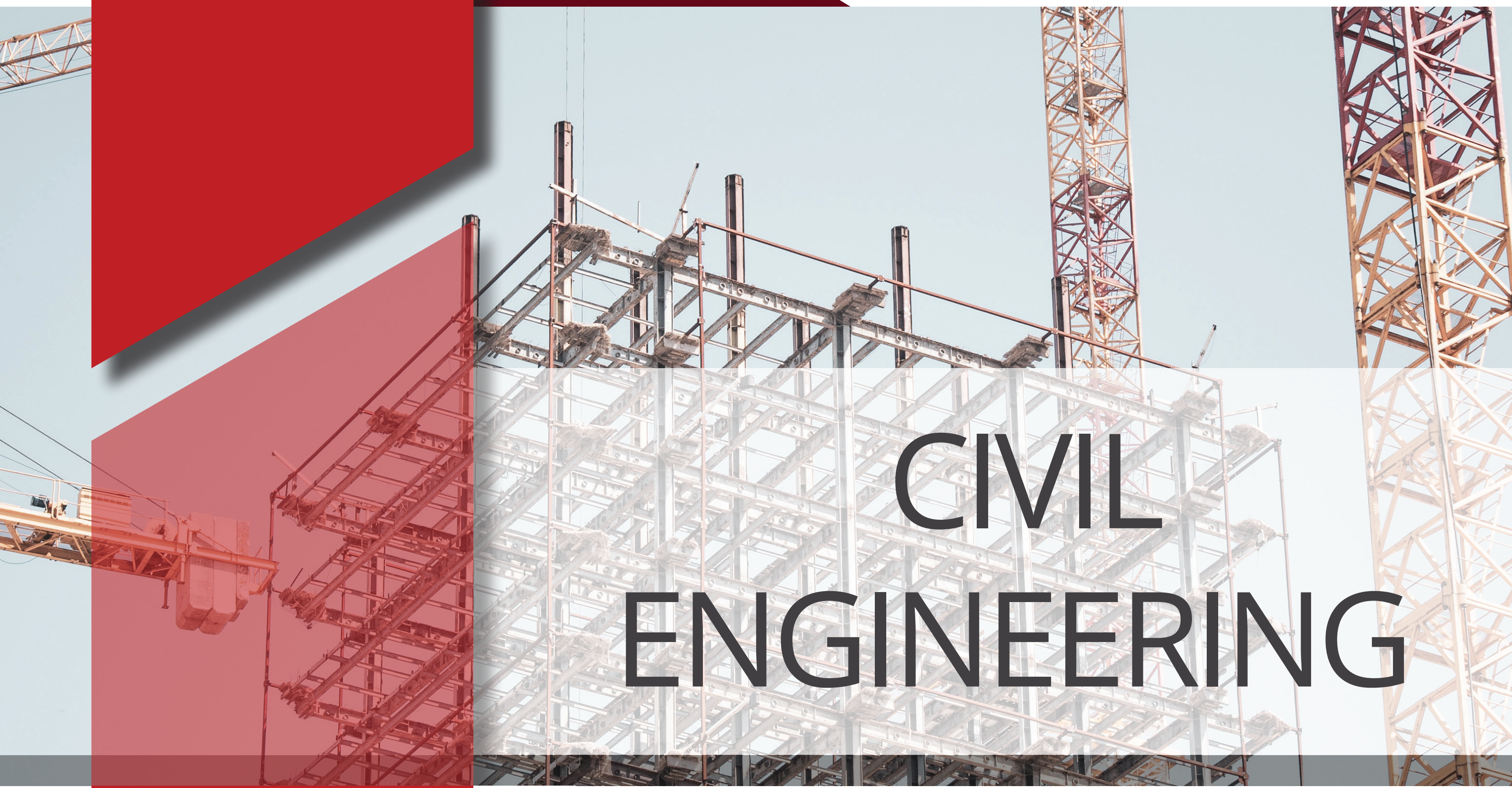
Interreg
EUROPEAN UNION
Austria-Czech Republic
European Regional Development Fund



CIVIL ENGINEERING

Building and environment

UNIVERSITY OF APPLIED SCIENCES UPPER AUSTRIA
VŠTE
EUROPEAN UNION

CONTENTS

1. BUILDINGS AND ENVIRONMENT

1.1. 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
    - Buildings for education, colleges, schools in nature, buildings for recreational events, buildings of health facilities, social facilities, accommodation facilities, buildings for trade and for gathering more persons.
- Other premises (Vehicles and other constructions, ...)

Indirect connection of the indoor environment with the outdoor environment and also due to the presence of various sources of pollution (for example constructional defects, characteristics of building materials, human activities, interior fittings and ambient air quality), it is often possible to observe that the indoor air has a different and specific microclimate.

1.2. Sick building syndrome

In 1983, the World Health Organization (WHO) defined these health problems such as Sick Building Syndrome (SBS). Nearly a third occupant suffered SBS in the 80s of the last century. 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 ...

Sick building syndrome in the city

The air in the city is full of smog. The indoor environment is hermetically sealed and enriched with a wide range of chemicals from furniture, plastics, PVC, smoke, static electricity. Synthetic covers and carpets are literally a cocktail of chemicals. ir inside the building is up to 10 times more dusty than outdoor air. It is clear that the air is not good for the health and well-being to the human body.

NASA's research (Rohles 1971, Jokl 1989) has long pointed out that the optimum level of living, i.e. without SBS, creates the optimal level of individual living environment components (The so-called constituent or components of the microclimate of the living environment): Thermal-humidity, odor, toxic, aerosol, microbial, ionizing, electrostatic, electromagnetic, electro-ionic, acoustic, and psychic.

1.3. 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

1.4. 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.

People spend up to 90% of their lives indoors. Microclimate is the basic user criterion of building quality. Microclimate affects human health and psyche. The material used on the building envelope, substances penetrating from the external environment, interior and human activities forms the 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

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.

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

Pollutant is gaseous, liquid or solid chemical, which has a harmful effect on living organisms at certain concentrations and duration of action.

Sources of pollution and pollutants of the indoor environment:

- Outdoor air: Carbon, nitrogen and sulfur oxides, ozone, solid particles, volatile organic compounds, polycyclic aromatic hydrocarbons, allergens (pollen)
- Outdoor environment: Soil gas, water
- Building (building material and equipment): 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 (bio-feeds), (micro) biological contamination, allergens
- Water: (Micro) biological contamination, allergens

2. TEMPERATURE AND HUMIDITY IN THE INDOOR ENVIRONMENT

2.1. Thermal-humidity microclimate

Thermal-humidity microclimate 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 an essential part of indoor air quality (IAQ) constantly influenced by the heat and humidity flows. Hygrothermal microclimate is defined by three fundamental factors - indoor air temperature [°C], indoor relative humidity [%] and air velocity [m/s]. Change one of the variables results in a change in the other two. The temperature and humidity within the building closely interact.

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, and dew point temperature.

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.

The final temperature of spherical thermometer (°C) is the temperature in the vicinity of the human body measured spherical thermometer that includes the effect of the simultaneous action of the air temperature, the temperature of the surrounding surfaces and air velocity.

The operative air temperature (°C) is the uniform temperature of the enclosed space within which one would share radiation and flow as warm as in the real environment. It is determined by the calculation.

The mean radiant temperature (°C) is the uniform ambient temperature, which is shared by the radiation as warm as in the real heterogeneous environment. It is measured by radiometers or calculated from the final temperature of spherical thermometer and air temperature. It serves as one of the input values for operating temperature calculation.

The temperature of the wet thermometer (°C), called psychrometric, is the temperature of the forced-ventilated wet temperature sensor used to determine the relative humidity of the air by a psychrometer.

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.

Dew point is the temperature to which air must be cooled to become saturated with water vapor. When further cooled, the airborne water vapor will condense to form liquid water (dew). When air cools to its dew point through contact with a surface that is colder than the air, water will condense on the surface.
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.

2.2. 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.

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.

Thermal comfort is a subjective feeling. The higher indoor temperature is, the lower the performance of occupants is. Performance decreases approximately 25% when the indoor air temperature is 27 °C. Only half of performance is assumed at an indoor air temperature of 30 °C.

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. It is necessary to ventilate shortly by the maximum cross section of the ventilation opening in winter.

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.

2.3. Humidity and heat comfort

Apartments with central heating is necessary to humidify in the winter. During this period, the relative air humidity drops to 20% or less due to heating, and thus intensive drying of the mucous membranes of the upper respiratory tract decreases their protective function and increases the possibility of penetration of harmful substances into the lower respiratory tract.

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. The humidity level of indoor air is affected by the operation of the household and the rate of ventilation. Humidity of in the indoor environment should not exceed 70% during the summer. In winter, the indoor relative humidity should not fall below 30%.

Higher humidity can lead to degradation of materials and structures, and the formation and growth of many kinds of microorganisms and mold formation. Low humidity can damage the mucous membranes (drying, loss of defenses, etc.)

Optimal heat-humidity microclimate occurs when there is a thermal balance of the human body without sweating with optimum heat flow from the body to the environment and optimum skin temperature, optimal uniformity of body heat load in space and time, optimum convection, radiation and vapor flow from the body to the environment.

3. ACOUSTIC MICROCLIMATE – BUILDING NOISE

3.1. Acoustics 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.

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.
An audible sound is capable of producing a sound sensation. It is noise whose frequency spectrum is located in one-third octave frequency bands with medium frequency of 20 Hz to 20,000 Hz.

Infrasound is a sound whose frequency range is in the third octave bands with a mean frequency of 1 Hz to 20 Hz.

Ultrasound is a sound with a higher frequency than audible sound. Its average frequency is 25,000 to 40,000 Hz.

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

In our population, the noise load is caused by an average of about 40% of the work environment and 60% of the outside work environment.

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.

In terms of reflection, we recognize the direct waves and the reflected waves.

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

3.2. Biological effects of noise

Acoustic flows act on the subject by acoustic pressure, which does not depend on the frequency of acoustic waves, but on their amplitude given by the magnitude of the source.

An acoustic pressure of 20.10-6 Pa characterizes the weakest sound recorded by undamaged human hearing. Human hearing is also able to withstand acoustic pressures more than a million times larger, that is a pain threshold of 200 Pa. In practice, this would mean working from tens to tens of millions of Pa, so the logarithm of these values, the so-called sound pressure level, was chosen. This adjustment narrows the range from 20 to 200,000,000 mPa to a range of 0 to 120 dB:

- L < 20 dB(A) - deep silence, adverse effect on psyche
- L 85 dB(A) – results in permanent hearing loss
- L = 130 dB (A) - threshold of pain
- L 160 dB (A) - the human drum breaks

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.

3.3. Optimization of acoustic microclimate

Noise maps express the burden of the population. Maps are geared to land use in spatial planning and strategy development.

Optimization of acoustic microclimate can be done in two basic ways - interference to the source of noise or interference in the field of transmission.

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

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). Currently, more theoretical possibility.

4. IONIZATION MICROCLIMATE

4.1. 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 ionizing radiation particles penetrate irradiated matter, breaks molecular bonds, and forms ions.

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.

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 activity of 1 Bq has a radioactive element characterized by one transformation per 1 second.

Volume activity is the quantity characterizing the number of radioactive conversions per unit of time in volume unit expressed in Bq/m3.

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. For example, the half-life of uranium 238U is 4.47 billion years old, half-life of radium 226Ra is 1602 years old and half-life of radon 222Rn is 3.82 days. Decay products are solids and are called daughters or progeny.

4.2. Sources of ionizing radiation

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.

The most common sources of radioactive substances from the outside air are radioactive ash produced by thermal power plants, badly stripped subsoil of buildings in localities with the occurrence of radon in the subsoil, inappropriate building materials (blocks produced from fly ash) and landfills. Cigarette smoke, X-rays, or radioactive materials in laboratories are the most common sources of ionizing radiation in the interior of buildings.

4.3. 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. Restriction or disposal of a source of radioactive material is the most effective way to optimize the indoor environment.

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

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.

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.

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.

5. RADON IN THE INTERIOR OF BUILDINGS

5.1. Basic characteristics of 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. Further, the radon is converted to the solids atoms 218Po, 214Pb, 214Bi and 214Pa with a half-life of 3.825 days. The entire chain is terminated with non-radioactive lead 206Pb.

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 1,2.103 kg/m

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. However, this is a long-term issue. The disease erupt after several decades of staying in a house with elevated levels of radon decay products. In general, the higher the concentration and the longer the exposure, the higher the risk.

The unit for volume activity of radioactive substances is 1 Bq/m3, which gives one average decay per second in 1 m3 of substance. Similarly, specific activity is defined for 1 kg of substance [1 Bq/kg]. The value of 1 Bq/m3 corresponds to 3.6 atomic decay of radon 222 per hour in one m3.

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. This value refers to the average value of the usual air change during use.

In outdoor air, the equivalent volume activity of radon (EOAR) is 7 to 12 Bq/m3. In the geological bed of rocks and soils, radon concentrations are three orders of magnitude (kBq/m3) higher.

Radon concentrations in ground air of rocks and soils range from units to hundreds of kBq/m3. Exceptionally, values above 1 000 kBq/m3 are mostly found on tectonic fault lines, fractures and mylonite zones.

5.2. Radon sources

In the wild radon emission surface from bedrock, where it immediately mixes with ambient air. This leads to its strong dilution and minimal effects on the human organism. On the contrary, it is in the indoor environment of buildings.

Radon in the rocks

If more radon measurements are performed in a particular rock type, then it is possible to roughly estimate the extent of radon volume activity in soil gas.The highest values of radon volume activity are typical of the magmatic rocks of the Bohemian Massif: durbacity and syenity, granites and granodiorites. Silurian sedimentary rocks originating in the Palaeozoons also have high radon volume activities but do not occupy large areas and therefore do not bring a high risk. Rock-shaped rocks such as the paramary, the orator of migamates, which have a medium radon index, occupy a large part of the Bohemian Massif. In the case of alluvial and tertiary sediments such as sandstone or sand, claystone, clays, the values of radon volume activity are generally lower.

The radon index also depends on the tectonic breakage of the rocks. The breakage of crushed surface areas in the rock increases the values of radon volume activity. There is a place for radon migration. Increased radon values can also occur on rock contacts with significantly different permeability and degree of weathering. In the case of determining the radon index category for a building site, it is appropriate to use all available geological information and background material because higher values of radon volumetric activity due to tectonics or rock contact may occur even in small areas.

Prognostic map distinguishes the areas according to the risks of radon ingress into buildings. In areas with high radon index is a higher incidence of homes with higher concentrations, while in areas with low radon index is excessively burdened little houses. In areas with a high radon index, the occurrence of higher concentration homes is more frequent. On the contrary, in the low radon index, overloaded houses by radon is minimum.The map was prepared by the Czech Geological Survey (authors I. Barnet, J. Mikšová, J. Procházka)

Occurrence of radon in indoor building environments

The current construction is characterized by the high airtightness of the building envelope. These constructions have well-sealed all structures such as roof, perimeter cladding, windows and ceilings. The higher the airtightness of the building envelope is, the higher indoor radon concentration is. Regular ventilation (natural or forced) reduces radon concentrations in high airtightness buildings. Low concentrations of radon are typical for buildings with leaky fillings of holes, which ensures a constant exchange of air.

The average value of radon in buildings in the Czech Republic is 118 Bq/m3. The Czech Republic is among the countries with the highest concentration of radon in apartments in the world.

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. The basic radon input paths are cracks in the concrete floor, contact masonry with the floor, cracks in masonry under the terrain, joints in the wooden floor, cracks in masonry, gap around the inlet pipe and cavities in the masonry. The building condition of the building has a significant impact on the amount of radon in the buildings (quality and condition of the insulation, sealing of the penetrations, etc.).

Using radon-rich water can release this gas into objects. It is not significant compared to the penetration of radon directly from the subsoil into the building. Water supplied from the public water supply is regularly monitored for the content of radioactive substances.

Radon in building materials

The source of higher volumetric activities of radon in the ambient air may be an increased concentration of radium 226 in building materials. Natural materials are crushed, milling and heat-treated, which can lead to a greater release of radon from the building material into the interior of the building. In the past, various types of waste (cinder or slag) used in building materials have proven problematic. At present, all building materials must have a radon certification.

5.3. Radon measurement

Radon cannot be perceived by human senses. The measurement is the only way to to reliably determine radon concentration in a building. A person certified by the State Office for Nuclear Safety can only perform the measuring activity.

The concentration of radon itself (also known as radon volume activity and referred to as OAR) or concentration of radon conversion products (also called equivalent radon volumetric activity and referred to as EOAR) can be measured.

The relation EOAR = 0.4.OAR is valid. Guidance values are expressed in concentrations of conversion products, and it is necessary to verify that they are reported in EOAR.

Measurements take place over a longer period of time because the radon concentration is not constant over time and it is changing over the course of the year and within one day. It is recommended to carry out measurements:

- Measurement for one year by trace detectors, if there is no rush
- Measurements for at least one week, when there is a rush and it is necessary to establish an indicative value

Emanation coefficient is the proportion of radon released and the total amount generated in building materials.

5.4. Anti-radon measures

If the concentration of radon conversion products in the house exceeds the reference level specified in Decree No. 422/2016 Coll., On Radiation Protection and the 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. A person certified by the State Office for Nuclear Safety may only conduct radon diagnostics.

Primarily, simple, fast and easy-to-implement measures are chosen which have the least possible impact on building structures and which do not significantly reduce the operation of the building. At the same time, it is usually a relatively inexpensive measure, which can gradually be performed by the owner of the house itself. 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. Careful implementation of insulation work and appropriate material selection is assumed. It is necessary to avoid undue interference with horizontal insulation and the use of unknown building materials.

Manufacturers of building materials are required to prove the safety of building materials in terms of the content of radioactive materials. At present, all natural radionuclides (not only radium) are monitored. The new assessment criterion is the mass activity index calculated from radia, thorium and potassium activities. The index is determined exclusively by the laboratory due to the relatively high content of natural radioactive elements anywhere in the soil.

6.TOXIC MICROCLIMATE

6.1. 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.

Sulfur oxides (SO2 and SO3 as byproducts of fossil fuel combustion), nitrogen oxides (gas engines, heat plants, gas burning), carbon dioxide (gasoline and incomplete combustion), ozone, hydrocarbons and smog come from the outside.

Toxic gases in indoor air generated by anthropogenic activities and released from building materials (NO2, CO). The most common toxic component of indoor building environments is carbon monoxide (CO). Its source is most often the combustion processes and the combustion of tobacco. In the case of good combustion, flue gases contain approximately 0.2-0.5% of carbon monoxide. In the case of incomplete combustion, these concentrations are considerably higher. Gas appliances without exhaust are also sources of nitrogen oxides. In addition, plastics in the interior are a source of toxic gas, for example, styrene is the emissied of polystyrene, volatile organic compounds evaporate very often from the coatings on heating surfaces.

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. Natural gas, which is used in the Czech Republic for cooking, heating or heating water, contains 5% of carbon monoxide. 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. Total nausea and vomiting are typical. In the case of heavier poisoning with carbon monoxide, there is a considerable tendency to fainting. At first, weak legs, a person stops feeling the ground under his feet, objects appear to be larger. Body temperature rises to 42 ° C.

The source of sulfur dioxide can be, for example, a domestic furnace in which coal is burned. In the 1970s and 1980s, sulfur dioxide was the main component of air pollution, but since the mid-1990s, its concentrations have been declining, due to improved flue gas desulfurization technologies for large sources of pollution. Sources include thermal power plants, heating plants and industrial boiler. Higher concentrations of SO2 irritate the upper respiratory tract, cough and increase respiratory illness.

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. They are nitrogen dioxide (NO2) and nitrous oxide (NO).

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. Ozone is not a pollutant directly discharged into the air and therefore, to reduce its increased concentration, it is necessary to reduce the emissions of the substances it needs to produce itself.

Ozone (O3 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.

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. According to the World Health Organization (WHO), volatile organic compounds are defined as organic compounds boiling in the range of 50 - 100 ° C to 240 - 260 ° C.

Volatile organic compounds are compounds, which, in the presence of solar radiation, react with nitrogen oxides and form photochemical oxidants. They have a demonstrably negative impact on the environment and air quality with negative impacts on human health. In the environment, they usually occur together as a sum of the compounds (TVOC). 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.

The sources of formaldehyde in the interior of buildings can be furnishings (furniture, carpets, wallpaper, etc.) or used building materials. Furthermore, cleaning and cosmetics used in households or plants, coal combustion, gas burning and smoking can be a source of formaldehyde. Outside sources are primarily transport industry. The concentration of formaldehyde in the interior depends mainly on the number of people, the interior fittings, the temperature and humidity of the environment. The presence of formaldehyde, thanks to its pungent odor appearing in small concentrations, is perceived by the smell. Therefore it is considered one of the safest indoor pollutants. Its impact on human health cannot be underestimated.

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 are characterized by long-term inertia capability in the indoor environment. These are substances with significant medical severity. 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). They are able to form other compounds that can be even more carcinogenic.

6.2. Optimization of toxic microclimate

Optimization of the toxic microclimate can be done by interfering with a source of pollutants, interfering with the field of transmission or by interfering with the subject. The basic method of optimization is ventilation.
In case of interference with the sources of pollutants, it is necessary to prefer materials of construction without toxic ingredients and volatile organic compounds. For technological heating installation, it is necessary to regularly carry out maintenance and cleaning in order to avoid reduction in the efficiency of the combustion process, and excessive production of carbon monoxide.

Intervention into the field of transmission constitutes a restriction on the spread of toxic substances in indoor environments. Methods of limitation of spreading include ventilation, filtration and decomposition of toxic substances into non-toxic or removal of toxic substances by intense air ionization.

The intervention in the subject exposed to the toxic microclimate involves the use of gas masks.

7. AEROSOLS IN THE INTERNAL ENVIRONMENT OF BUILDINGS

7.1. Aerosol 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.

The dispersion system is a system of at least two types of phases, one phase (the disperse phase) being dispersed in the other (dispersing medium).

The dispersed phase material is formed by dispersing particles of a team.

The aerodynamic particle diameter is the particle diameter at a density of about 1 g/cm3 falling stalling speed caused by gravity at a steady temperature, pressure and humidity.

Solid particles of PM10 (particulate matter) contain particles with a particle size of 2.5 to 10 µm, with 50% of these particles having an aerodynamic diameter of 10 µm.

Solid particles of PM2,5 (particulate matter) contain particles with a size of 2.5 or less, with 50% of these particles having an aerodynamic diameter of 2.5 µm.

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/km2 per year at a standard concentration of 1 to 3 mg/m3.

Domestic dust, especially biological particles below 1 micrometer, are the main cause of asthma affliction. The permissible value in normal buildings is the concentration of inert solid aerosols of 10 mg/m3.

7.2. 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.

Dust particles of plant and animal origin are lighter than the inorganic particles. These particles are mostly fibrous, branched in tufts. While the inorganic particles are prismatic or spherical in shape with smooth or sharp edges. 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.
The best known example of a liquid aerosol is the fog that is formed by the condensation of water vapor when the temperature drops below the dew point. Other liquid aerosols are produced in industrial plants. According to the composition, liquid aerosols may be either monodisperse (particles of approximately the same size) or polydisperse (particles of different sizes).

According to the particle size, there are vapors (particles less than 10-4 mm) and sprays (particles larger than 10 mm). Immediately after its formation, the liquid aerosol particles change their shape, which is due to the evaporation of the fluid or the influence of particle aggregation.

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.

7.3. Biological effect of aerosol climate

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.

The effects of aerosol particles on the organism can be characterized in terms of physical (mechanical properties), chemical (toxicity), physico-chemical and biological (allergy and carcinogenicity).

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.

7.4. Criteria of aerosol microclimate

There are no criteria that would be able to determine the maximum allowable flow of aerosol to the organism. Most regulations set the maximum allowable concentration of aerosols in the air. In outdoor air for dust with a maximum SiO2 content of 20%, an average daily concentration of 0.15 mg/m3 is permitted and the fall of dust may not exceed 150 tonnes per km2 per year.

7.5. Optimization of aerosol microclimate

Optimization of the aerosol microclimate can be accomplished by interfering with an aerosol source or by interfering with the transfer field.

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

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)

The last measure against aerosols is the use of protective equipment such as glasses, respirators and suits. These protective aids are extremely inconvenient. Their use should only be exceptional. There are workplaces where we cannot do without them - eg paint shops, chemical plants, operating theaters, mining and textile factories, and others.

8. ODORS IN THE INTERIOR OF BUILDINGS

8.1. 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)

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. They are released from building materials and building facilities.

Olfakometry is a method of objectively determining odorous substances in the air based on human olfactory senses.

The threshold of perception is the lowest odor concentration at which the odor air is distinguished from the sensorless air by 50% of the assessors based on the primary air perception of the test air.

The detection threshold is the lowest odor concentration at which air with odorous substances is distinguished from the sensorless air of 50% of the assessors based on the clearly recognized sensation of the odor in the test air.

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.

8.2. Biological effects of odors

Odorous substances have to encounter the mucous membrane to cause olfactory sensation. Ocular cells then transmit electrochemical impulses to the olfactory center in the front of the brain. A part of the brain, which is involved in the stench, is placed over the nose and it creates emotions. This implies that odors affect mood creation.

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

8.3. 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.

The most effective way to optimize is to reduce or completely eliminate the odor source, for example by using fast-drying colors (colors that, in contact with UV radiation, cause a very rapid transition of low molecular weight to high molecular weight compounds) or waste bins.

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. The principle of limiting the spread of odors in the building consists in the distribution of vertical shafts into several parts or appropriate placement resources odors. The amount of fresh air is related to the odor concentrations in the indoor environment.

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. Active or charcoal filters do not absorb almost any moisture and do not change the air condition. Their effectiveness depends on the time of gas contact with coal. For at least 80% efficiency, a layer of active coal at least 25 mm thick is required and the flow rate through the filter should not exceed 3.0 m/s. Washing air with by water is especially effective for substances that are capable of binding to water, such as ammonia. 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. Biological filters comprise a natural filling - peat, in which the microorganisms are capable of degrading aromatic compounds, such as hydrocarbons. A great advantage of these filters is their low operating costs.

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

The neutralization effect is based on ionized ozone, which is a strong oxidizer. Molecules of odorous substances are decomposed and converted into water vapor, carbon dioxide and other non-odorous substances. Consideration must be given to the concentration of ozone due to its toxicity.

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

Houseplants are not only an adornment and a consumer of CO_2, but some species are also able to purify the air from benzene, carbon dioxide, nitrogen dioxide and formaldehyde

9. MICROORGANISMS IN INDOOR MICROCLIMATE

9.1. 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.

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.

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

The most common, but not the only, source of microorganisms are humans themselves. People spread germs microorganisms in indoor and outdoor air. Microorganisms are then spread to air-conditioning and air-conditioning equipment.

The main carriers of microorganisms are liquid aerosols and solid aerosols (dust). Therefore, it is necessary to prevent the accumulation of dust in enclosed and hard-to-reach air ducts (by means of back flaps, guaranteed overpressure, etc.), as there is a risk of viruses and molds with unlimited life.

An intensive source of microorganisms can be hot-air heating, ventilation and air conditioning systems, filtration equipment, humidifiers and dehumidifiers, air ducts and double ceilings.

Microorganisms that get into the air from clothes, talking, coughing, sneezing remain in a humid air environment for a long time. They associate in the air with fine water droplets that do not sediment. The duration of droplets in the air depends only on their size.

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.

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

In buildings, psychrophils and alkalophiles, or osmophils and oligophils, are the most common. Structural elements of houses and flats (wooden beams, masonry, floor coverings, window frames, etc.) can be sources of molds that need to have conditions for their existence and further growth. These are four basic conditions, the so-called moisture requirements, temperature requirements, pH building materials requirements, nutrient requirements.

Mold can be expected wherever there is high humidity. Building structures with high humidity are a breeding ground for mold. In recent years, there has been a rise in mold incidence in many dwellings. The reason is replacement of windows. Insufficient ventilation (new airtight windows) causes a rise in humidity. Another source of moisture, as shown by the State Health Institute, is also the leakage through the roof or the rise of the groundwater. These defects are not only aesthetic, for most of these fungi are allergic to humans. The influence of oxygen and the influence of solar radiation may vary from species to species.

9.2. Quality 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/m3, in the urban environment there are concentrations of up to 1500 microbes/m3. Environmental quality requirements for conventional buildings are met, if bacterial or mold concentration do not exceed of 500 KTJ/m3 of air (colony forming units).

9.3. Optimization of microbial microclimate

Optimal microbial climate can be ensured in two basic ways:

- Intervention to the source of microorganisms
- Intervention in the transmission source resource field to the exposed subject
- Intervention into the source of microorganisms include, in particular purity skin care, clothing and footwear and isolation of patients. It is recommended to replace the shower chamber in the air conditioning system by a steam humidifier where the humidification is achieved by spraying the water vapor to the heater. It is necessary to drain condensed water vapor. It is better to choose dry methods than dehumidifying equipment than condenser on the radiator. Dryer air filtration methods are better, ie the relative humidity of the air through the filter does not exceed 70%. Elimination of the occurrence of condensation of water vapor on the walls can be done by the addition of thermal insulation, a suitable method of heating, ventilation and dehumidification equipment installations.

Interventions in the field of transmission include the reduction of the spread of microbes in a building by ensuring the purity of the interior, removing unpleasant insects, sufficient fresh air (ventilation), air disinfection by UV irradiation, or by the application of suitable modifying substances in the surface film.

10. ELECTROSTATIC AND ELECTROMAGNETIC ENERGY IN THE BUILDINGS

10.1. 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. The higher the pressure or the separation rate is, the higher the charge is. Static charge occurs abundantly in the winter months (low humidity). Is it because some materials are able to absorb moisture (water) from the air into itself and thereby become more conductive.

10.2. Sources of static electricity

Probably the largest static energy source on Earth is watercourses, where static electricity is generated by friction of water molecules on the rock or on the subsoil. The energy components (auras, zones, inter-zones) of underground springs, streams, rivers, beaches, ocean currents and shores create a massive three-dimensional grid across the Earth, whose conductive components interact with components of storm clouds and other charges. Due to the varying flows of watercourses and the movement of storm clouds, all three components of static electricity are in constant motion. This adds to the energy to fauna and flora.

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

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)

10.3. Optimization electrostatic microclimate

The optimal electrostatic microclimate is characterized by a minimal incidence of static electricity. Complete exclusion of static electricity is unrealistic. It is advisable to minimize static electricity.

Potential occurrence of static electricity must be eliminated e.g. suitable grounding or appropriate modification of transfer. It is necessary to divert the accumulated charge in the shortest possible time to avoid the accumulation of high potentials. The optimization of the electrostatic climate can be done either by interfering with an electrostatic source or by interfering with the transmission field.

The electrostatic source can be adjusted by means of antistatic agents and grounding. Conductive films from water to high molecular weight ammonium halogens are commonly applied. Appropriate clothing and footwear can also reduce the generation of static electricity.

Air conditioning and surface finishing of walls and floors can optimize the electrostatic field. The creation of an optimal electro-ionic microclimate can be done by inversion by air ionization or by increasing the relative humidity of the air. The risk of static generation is already minimal at relative humidity values of 60-70%. For floors and walls it is desirable to use antistatic coatings and perfect grounding.

10.4. 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. An internal source of electromagnetic radiation can be, for example, microwave heating, mobile phones, monitors, screens and other electronic appliances.

A magnetic field is always created around the conductor with the electric current passes. Conversely, if the magnetic field changes, then the electrical current is always induced in the conductor. Every change in the electric field induces a change in the magnetic field and vice versa.

10.5. Sources of electromagnetic radiation

- High voltage lines, underground cables, transformer stations
- Base station antennas (BTS) and high-speed internet
- Mobile, radio and television transmitters
- Security systems
- Electrical circuits such as sockets, lighting, underfloor heating
- Domestic appliances, microwave, television, remote controls
- Mobile phones and computers, WiFi devices
- Children's remote control toys and baby monitors

Electrosmog is all the invisible radiation emitted by household electrical appliances. Electrosmog is the electromagnetic radiation that occurs when electricity is produced and transmitted - when using electrical appliances, in mobile networks, in telecommunications, but also in television and radio broadcasting. 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.

10.6. 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.

10.7. Optimization electromagnetic microclimate

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. The most efficient way is to completely eliminate the source of electromagnetic radiation. Interference into the electromagnetic radiation source is to eliminate the source, which is the most effective way to ensure optimum electromagnetic climate. Shields use aluminium or copper sheets with a thickness of at least 0.5 mm. The shielding must be properly grounded. Interference to the transmission field lies in the local shielding according to the same principles as the source policies.

10.8. Protection against electro-smog

- Switch off electrical equipment when it is not in use
- Turn off the WiFi device at night; disconnect the lamp on the nightstand from the outlet. At night, turn off the cell phone or switch it to Airplane mode
- Do not stand on the wall behind which there is an electrical appliance
- Leave a distance of 0.5-1 meter from the cable and the extension
- Avoid using babysitters

There are protective elements against electromagnetic radiation such as special protective plasters, scratches, facades, paints and floors. In addition, there are also window shades, shading fabric on the wall or special mobile phone cases.

11. ELECTRO-IONIC MICROCLIMATE

11.1. 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.

The gas molecules are electrically neutral Under normal conditions. Due to the effect of ionizing energy, there are non-elastic collisions of neutral molecules. As a result of these precipitations, electrons are pulled from the orbital sphere of atoms and thus a pair of electrically charged particles is formed. These particles are not stable, they connect with neutral atoms or molecules into clusters (up to 30 molecules) that are more stable, they are called light ions.

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.

11.2. 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 formation of air ions is influenced by the ionization of radiation from natural radioactive substances contained in the environment (soil, air), cosmic rays and the radiation of heavy particles coming into the higher layers of the atmosphere from the sun. Also ultraviolet radiation.

In the interior of buildings, 222Ra and 220Ra can also be a powerful source of aeroions, and they are contained in construction structures (granite and concrete) that diffuse into the room. Concentration of airfoils, especially with reduced room ventilation, can then be considerably higher than in the exterior. In such a case, radon and its modifications in air can exceed the maximum allowable values for long-term residence and become a serious danger that the user has no clue and cannot perceive by their senses.

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.

11.3. Effects of ions on human organism

Aeroionts primarily serve to accelerate biochemical reactions. Small or even negative ions are positive for the organism. They have a positive effect on the respiratory system, where they give up their charge, which is positively manifested by increased activity of ciliary epithelium and mucus production, EEG, changes in blood pressure, basal metabolism and a subjective sensation of freshness. The positive influence of light negative ions was observed in asthmatics, allergens and rheumatism.

Negative ions (anions) in the body to cause an increase in blood pH, decrease blood pressure, decrease in oxygen consumption, increase 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.

The predominance of cations in the air is demonstrated in nature by the adverse effects of some dry warm winds. Substances that affect the ions play an important role in the metabolic effects and the transfer of certain impulses in the lower midbrain, which is very important for the production of sleep and overall mood of a person.

Air poor on any ions is referred to as "heavy". Air with a predominance of positive ions is referred to as "snooze". Air with the predominance of negative ions appears to be "cold". The air with the optimal ratio (p/n = 5/4) is described as "light and fresh". The formation of medium and particularly heavy ions should be avoided. Air cleanliness is essential. Electro-ion microclimate must always be solved together with an aerosol microclimate.

The content of light negative ions in the indoor environment of buildings is reduced by anthropogenic activity such as smoking. Smoking greatly reduces light ion content in the room for several hours. In a smoky environment people feel nonspecific type of problem irritation, increased fatigue, difficulty of concentration and decrease work performance. Sleep disorder and insomnia may occur.

11.4. Optimization electro-ionic microclimate

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

Aeroions get into the indoor environment by ventilation, naturally through windows or forced ventilation, which do not discharge electrically charged particles. Occurrence aeroins significantly influences and used building materials and surface finish. It is recommended to use classical building materials such as bricks and wood. Uncoated raw wood neutralizes a considerable amount of aeroion on its surface, unlike smooth veneer.

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.

12. PSYCHIC AND LIGHT MICROCLIMATE

12.1. 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

12.2. 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

Daylighting is more appropriate for the human body than artificial lighting. Human biorhythm is also associated with regular alternation of light and darkness. The minimum level of daylighting, characterized daylight factor [%] must be ensured in residential buildings.

The criteria used to describe the light microclimate are:

- Daylight factor
- Illumination
- Temperature of chromaticity
- Color rendering index (CRI)
- Glare index

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. The contribution of direct sunlight to both light intensity is eliminated. The value of daylight factor is expressed as a percentage.

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 (m2).

12.3. Color of the space

Visual perception of colors creates feelings of warmth and cold. Physiological functions, including basal metabolism, are accelerating due to warm colors. Conversely. The change also depends on the current psychological state. Green and blue are passive and cold-acting colors that support mental concentration and longer work performance. Heat-acting colors (red, orange or yellow) are dynamic stimulating colors.

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. Receptors called three-colored suppositories that are sensitive to three basic colors - red, green and blue, mediate color vision. All known colors are based on these three basic colors.

The color perceived by the eye can affect the feelings transmitted by the touch or muscular tension in the brain (the same objects may be considered lighter or heavier in terms of color). Color also influences the concept of space (The room may be optically enlarged or reduced, height increased or decreased) because the overall color of the environment generates feelings of volume or stiffness, or it is involved in these feelings. The research in 1977 found that warm colors have up to 0.4 ° C shifted thermal comfort compared to cold colors.

Generally, black is about 25 times darker than white. If a 40-Watt light bulb is sufficient to illuminate a room with white walls, then we would need a 1000 W bulb for the same light perception in a room with black walls.

12.4. 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.

12.5. Optimization of psychological and light microclimate

The color of environment and its components creates the overall psychological effect on the environment of the organism. There is no comprehensive optimization of light microclimate. The objective of optimizing the mental and light microclimate is to create a sense of visual comfort. Visual comfort (well—being) is the state of the organism, in which the visual system functions and in which one feels in light comfort.

LITERATURE

BEDNÁŘOVÁ, Petra a Jana KREJSOVÁ, 2008. Zdravé domy pro zdravé lidi, VŠTE v Českých Budějovicích. ISBN 978-80-903888-9-5.

GODISH, Thad. Indoor environmental quality. Boca Raton, Fla.: Lewis Publishers, 2001. ISBN 1566704022.

JOKL, Miloslav. Zdravé obytné a pracovní prostředí. Praha: Academia, 2002. ISBN 80-200-0928-0.

JUHÁSOVÁ ŠENITKOVÁ, Ingrid. Vnímaná kvalita prostředí a výkonnost uživatelů budov. 1. vyd. České Budějovice: Vysoká škola technická a ekonomická v Českých Budějovicích, 2016. 136 s. ISBN 978-80-7468-104-2.

KRAUS, Michal a Ingrid JUHÁSOVÁ ŠENITKOVÁ, Indoor Air Quality of Residential Buildings. In: In 17th International Multidisciplinary Scientific GeoConference, SGEM 2017: Book 6 Nano, Bio and Green – Technologies for a Sustainable Future, Sofia (Bulharsko): International Multidisciplinary Scientific Geoconference, 2017.

KRAUS, Michal a Ingrid JUHÁSOVÁ ŠENITKOVÁ, Indoor Environment in Residential Prefabricated Buildings. In: World Multidisciplinary Civil Engineering-Architecture-Urban Planning Symposium 2017, Prague.

KRAUS, Michal a Ingrid JUHÁSOVÁ ŠENITKOVÁ, Indoor Environment in Residential Prefabricated Buildings. In: World Multidisciplinary Civil Engineering-Architecture-Urban Planning Symposium 2017, Prague.

KRAUS, Michal, Hygrothermal Analysis of Indoor Environment. In: World Multidisciplinary Civil Engineering-Architecture-Urban Planning Symposium 2017, Prague.

KRAUS, Michal, Hygrothermal Analysis of Indoor Environment. In: World Multidisciplinary Civil Engineering-Architecture-Urban Planning Symposium 2017, Prague.

KRAUS, Michal. Airtightness as Key Factor of Sick Building Syndrome (SBS). In 16th International Multidisciplinary Scientific GeoConference, SGEM 2016: Book 6 Nano, Bio and Green - Technologies for a Sustainable Future, Volume II. 1. vyd. Sofia (Bulharsko): International Multidisciplinary Scientific Geoconference, 2016. s. 439-445, 7 s. ISBN 978-619-7105-69-8. doi:10.5593/sgem2016B62.

NEZNAL, Matěj a Martin NEZNAL. Ochrana staveb proti radonu. Praha: Grada, 2009. ISBN 8024730650.

Radonový program České republiky [online]. Praha: Státní úřad pro jadernou bezpečnost, 2016 [cit. 2017-06-21]. Dostupné z: http://www.radonovyprogram.cz

Státní ústav radiační ochrany, v. v. i. [online]. Praha: SÚRO, 2017 [cit. 2017-06-21]. Dostupné z: https://www.suro.cz/cz

ŠENITKOVÁ, Ingrid, Silvia VILČEKOVÁ a Marcela ONDOVÁ. Budovy a prostredie. 1. vyd. Košice: TU, SvF, 2011. 165 s. ISBN 978-80-553-0668-1.

TŮMA, Jiří. Tepelná pohoda [online]. Praha: Fakulta elektrotechnická, ČVUT, 5228 [cit. 2017-06-13]. Dostupné z: http://heat.feld.cvut.cz/mertaj/tuma2.html