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MICROCLIMATE PROPERTIES OF INDUSTRIAL PREMISES

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Abstract
This paper classifies industrial microclimates based on their impact on workers. It is shown that air movement in industrial spaces is generated by convection currents resulting from uneven heating of air masses from heat sources, which is influenced by outside wind, machinery, mechanisms, and electric motors.

Keywords: Classification, microclimate, air, temperature, humidity, convection flow, intensity, infrared radiation.

Introduction
The microclimate of industrial premises is defined as a set of physical factors of the production environment (temperature, humidity, air mobility and thermal radiation from surrounding surfaces) that affect the thermal state of the human body.
The industrial microclimate can be influenced by the nature of the technological process, indoor air exchange conditions, external meteorological conditions, and seasons and times of day. Industrial microclimate is characterized by wide variability in the factors that comprise it and varying combinations of their levels [1-10].
Based on the nature of the impact on the body of workers, the following classification of industrial microclimate is proposed:
1. Microclimate of hot shops:
a) with a predominance of radiant heat (blast furnaces, open-hearth furnaces, foundries);
b) with a predominance of convection heat (boiler-turbine, paint shops).
2. Microclimate of cold shops:
a) cold microclimate maintained artificially (refrigeration shops in the food and other industries);
b) microclimate of unheated premises (this group conventionally includes the microclimate of open areas during cold periods of the year).
3. Microclimate with pronounced fluctuations in its main factors (most hot workshops during cold periods of the year).
4. Microclimate created artificially (by heating, ventilation and air conditioning system).

Microclimate can be classified as follows:
1. comfortable (assembly shops, control rooms);
2. with high humidity, at normal and low air temperatures (fish processing shops); at high air temperatures (painting shops);
3. variable (when working outdoors);
4. heating with a predominance of radiant heat (rolling and foundry shops) and with a predominance of convection heat (chemical shops);
5. cooling with subnormal air temperatures (from +10° to -10 °C – shipbuilding) and with low air temperatures (below -10 °C – cold rooms).

The microclimate of production facilities can change throughout a work shift, be different in different areas of the same workshop, etc.

Air temperature is the degree of air heating , expressed in degrees Celsius (°C). High air temperatures are observed in rooms where technological processes generate significant heat. Air heating can be caused by powerful industrial sources (smelting furnaces, heating furnaces, etc.), heated materials and objects being processed, the operation of machinery and electric motors, sunlight, and people.

Low air temperatures, sometimes with increased humidity and air movement, are observed during outdoor work during the cold season, especially in certain climate zones; they are noted in workplaces in refrigerators and unheated warehouses; the temperature in the cabins of machines and mechanisms is often low (during the cold season).

Air humidity is the content of water vapor in the air. Humidity is classified as absolute, maximum, and relative.

Absolute humidity is the elasticity of water vapor in the air, expressed in mm Hg (or mass in grams per 1 kg of air).

Maximum humidity is the elasticity of water vapor when the air is completely saturated with moisture.

Relative humidity is the ratio of absolute humidity to maximum humidity, expressed as a percentage.

Air humidity in the work area is expressed as relative humidity (%). Humidity in industrial settings can vary greatly depending on the nature of the process. In some industries with moisture sources (dyeing, electroplating, weaving, tanneries, etc.), relative humidity reaches high levels of 80–100%. Lower humidity occurs in areas with harsh continental climates and dry subtropical zones. Construction workers, masons, road workers, drivers, and others work in such conditions.

Air movement in industrial spaces is created by convection currents resulting from uneven heating of air masses from heat sources. It is influenced by outside winds, the operation of machines, mechanisms, and electric motors. Air velocity is measured in meters per second (m/s). Increased air movement in the work area occurs during outdoor work, opening doors and gates in workshops, and when ventilation systems are operating, among other factors.

Radiant heat (infrared radiation (IR)) is electromagnetic radiation (EMR) of a specific wavelength (spectrum) that possesses thermal properties (wave and quantum). IR radiation is EMR with a wavelength of 0.76–540 µm. It passes through the air without heating it, but is absorbed by objects and bodies, causing a thermal effect. IR radiation is subject to a number of important hygienic principles.

Kirchhoff's law : the emissivity of any body is proportional to its absorption capacity.

Radiation emission is determined solely by the state of the emitting body and is independent of the ambient temperature. This is why nickel-plated or chrome-plated surfaces of industrial equipment emit less heat. The development of protective clothing, light filters, and infrared radiation measuring devices is based on this law.

Stefan-Boltzmann law: the emissivity of a black body is proportional to the fourth power of its absolute temperature:

$$E = K \times T^4$$

where: E is the radiated power,

K is a constant (1.38*10-12 cal /(cm*s),

T – absolute temperature (T +273°C).

Thus, even a small increase in temperature leads to a significant increase in radiative heat transfer. Knowing the Stefan-Boltzmann law makes it possible to determine the magnitude of radiative heat transfer in industrial settings, since radiation intensity is important in addition to the spectral characteristics.

Wien's Law (the displacement law): the wavelength of maximum radiation emitted by a heated body is inversely proportional to its absolute temperature. Alternatively , the product of the absolute temperature of the radiating body and the wavelength of radiation (λ) is a constant (or, as the body's temperature increases, the maximum radiation energy shifts toward shorter wavelengths) [11-16]:

$$\lambda_{max} \times T = \text{const. 2898 мм} \times {}^{\circ}\text{C}$$

Knowing Wien's law and having data on the temperature of the emitting body, we can understand the spectral characteristics of infrared radiation and assess its biological effects. Long-wavelength rays have a wavelength greater than 3 µm, medium-wavelength rays have a wavelength of 1.4–3 µm, and short-wavelength rays have a wavelength less than 1.4 µm.

The wavelength determines the penetrating power of the rays and their biological effect. Short rays penetrate tissue to a depth of several centimeters, while longer ones are absorbed by the upper layers of the skin. Wavelengths of 3 and 6 microns are particularly strongly absorbed. The color, smoothness, and thermal conductivity of the emitting body influence the radiation intensity.

The intensity of infrared radiation is measured in the number of small calories falling on 1 cm2 of surface per minute (cal/cm2 * min) or in kilocalories per 1 m2 / hour.

Infrared radiation is the primary climate-forming factor in hot shops. Surrounding objects that are cooler than the IR source are heated. In industrial settings, people are exposed to radiant heat from the sun, open flames, hot and molten metal, and equipment surfaces. Radiant energy is assessed by quantitatively measuring the integrated radiant energy flux and determining its spectral composition.

It should be remembered that in hygiene practice, IR radiation is assessed based on the intensity of thermal irradiation of workers' body surfaces, expressed in W/m2. IR radiation plays a vital role in human heat exchange with the external environment, as the body's heat loss occurs largely through radiation.

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