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## The impact of thermal radiation on the human body

### Annotation

Heat radiation - essentially negative phenomenon, it affects the thermal regime of the workplace. Thermal radiation is not valid until it reaches the absorbing object; it passes through the air without heating it. The flow of air between the source of heat radiation and man does not prevent its effects on humans. Of the reduction of heat radiation in hot shops is more economical compared to other methods of protection.

Ways to reduce heat radiation - reducing heating machine or improvement of thermal insulation hot surfaces - to reduce the intensity of thermal radiation machine, bare light planes can reduce the layer of aluminum foil or a clean aluminum filler (aluminum putty cannot be used to cover the high temperature heating elements as it reduces the coefficient emission by 50% compared to the enamel) - use of the cover or barrier between the source of thermal radiation and infrared person "shadow"), such as absorbing (asbestos, glass, water-cooled, chain, valves, metal grids) or reflective screens (aluminum sheets or foil glued to asbestos plate), which reflect the 90 - 95% of infrared rays, aluminum putty represents two thirds of the infrared - cooling the working due to supply and blow dry and cool air at a certain speed, depending on the intensity of heat radiation, water curtain minimum thickness of 10 mm, but when using it increases the likelihood of increasing the relative humidity in a room that has a negative effect on the working (increased fatigue) - use of personal protection from radiation (protective clothing).

Keywords: heat radiation, infrared radiation, disabled person after exposure to radiant heat, the essence of the thermal action of destruction of people, how to reduce heat radiation.

Кілт сөздер: жылулық сәулелену, инфрақызыл сәуле, жылулық сәуле әсерінен кейінгі адамның жұмысқа қабілеттілігі, халықтың жылулық әсермен зақымдалу маңызы, жылулық сәулені азайту тәсілдері.

Ключевые слова: излучение тепла, инфракрасное излучение, трудоспособность человека после воздействия теплового излучения, сущность поражения людей тепловым действием, способы уменьшения теплового излучения.

### Introduction

Man, if he is suitably dressed, able to endure the ambient temperature in a relatively wide range. In Antarctica, the temperature of the environment in its minimum can be close to  $-90^{\circ}\text{C}$ , the highest temperature in many parts of the earth can reach  $+58^{\circ}\text{C}$ . However, the human body itself can only operate within a relatively narrow range of temperatures, and so the people in most climatic conditions required wearing certain types of clothes.

The human body can be exposed to extreme heat or cold when exposed to hot or cold; respectively substances in solid, liquid or gaseous form and supply the human body heat or diverting it. However, these sections will only harmful effects of heat, but not cold. Attention will be paid mainly to thermal effects of fire and the consequences of this action, but do not burn that due to contact with hot liquids (with the basic mechanisms - conduction and convection).

The amount of heat absorbed by the human body from the radiation source, in principle, can be calculated by applying the laws of physics. However, although the effects of radiation on the human body as a whole is determined by the laws of physics to predict the impact of this, you must also know the human anatomy and physiology, the necessary information from these disciplines will be presented here in a general way and only to the extent that they relate to aspects of basic chemical hazards. Will be excluded from consideration of issues related to the burns that occur in contact with corrosive chemicals, inorganic acids and alkalis.

The essence of the action of heat shock to persons. Burn defeated man described in the book [Mason, 1978]. The total number of deaths caused by thermal injury (including burns), in the UK in 1975 was 495 people. With a trend towards reduced mortality by about 20% compared to the previous decade. In the cited paper it is noted that this figure - only half of the number of deaths that occurred in fires, and the other half are accidents that have occurred in fires from choking or inhalation of carbon monoxide and other toxic gases. For every person killed by thermal injury, we have twenty people who are being treated in hospital for an average of 5-6 weeks, and 200 people who attended the Department of Traumatology at the hospitals. Approximately half of the people out of the requesting assistance did not reach the age of ten. Two-thirds of affected adult men were burned at work.

Mason [Mason.1978] argues that it is hardly explosive bombs to cause burns. This is not entirely true. The bomb weighing 13.5 kg forms a ball of fire about 9 m in diameter, which quickly dissipates in the open. However, the explosion in a confined space, people can get burned. Defeated by napalm - funds used for military purposes and consisting of a mixture of liquid fuel, such as gasoline, and powder-thickener (aluminum soap made from coconut oil), naphthenic and oleic acids can be very heavy. At temperatures above  $1000^{\circ}\text{C}$ , the gases formed and, therefore, confined spaces; there is a possibility of death from asphyxiation or carbon monoxide poisoning. Choking can occur from inhalation of hot gases that burn or choke destroy the alveoli (air sacs in the lungs).

Obviously, there is a threshold below which there is no thermal damage. The bath temperature is usually  $36 - 42^{\circ}\text{C}$ . However, the ten-contact with water having a temperature of  $60^{\circ}\text{C}$ , resulting in a partial loss of the skin, and contact for 10 seconds with water heated to  $70^{\circ}\text{C}$ , causing a complete loss of skin.

In areas with a temperate climate effects of solar radiation on humans for most of the year slightly. However, it is a year for several days, when sunlight can cause skin burns. Essentially,

there is an upper limit of the temperature sensitivity of the skin, and when it is exceeded, there is a defeat, the pain is being felt at the skin of about 44 °C. The calculation of the intensity of the radiation that causes this temperature is complicated by the presence of a person cooling mechanisms, such as sweating and bleeding. Skin reaction depends not only on the intensity of the radiation, but also on the duration of its effects.

What has been the effect of IR radiation?

Action infrared heat based on the selection of infrared (heat) waves. Infrared waves are natural, completely safe in waves. The largest and most important source of radiant heat for us is the sun. Infrared radiation - is invisible wavelength range of electromagnetic radiation. The unique design of radiators, these waves can penetrate into the human body to a depth of 4 cm. This is the deep penetration of infrared waves transmitted to the body heat and improves the overall condition. Infrared waves heat the tissue, organs, muscles, bones and joints and accelerate the flow of blood and other body fluids. Strengthening the blood circulation increases metabolic exchange, which in turn strengthens the immune system, improves muscle power, and greatly increases the supply of oxygen to tissues. Scientific studies have shown that the most beneficial effect on the human body it has long-wave infrared radiation, especially that part of it which is adjacent to the middle under the range - the so-called "Rays of Life" (the wavelength of 5 - 20 mm). In this range is an infrared radiation floor heating and infrared heater. Thermal emission rights are in the same range.

Health. Heat radiation - essentially negative phenomenon, it affects the thermal regime of the workplace. Thermal radiation is not valid until it reaches the absorbing object; it passes through the air without heating it. The flow of air between the source of heat radiation and man does not prevent its effects on humans. Of the reduction of heat radiation in hot shops is more economical compared to other methods of protection.

The intensity of the thermal radiation in the workplace rights should be (according to the hygiene standards MZ) less than 4.15 kJ / (sm<sup>2</sup>min). Where the value of intensity equal to or greater than the above values, it is necessary to resort to a reduction of heat radiation.

All heated to varying degrees, the body and emit infrared light. The human body is an exception to this rule is not - its range of radiation from 6 to 20 pm, with a peak of 9.6 micron emission (bioresonance frequency). Therefore, any external radiation with wavelength, the body perceives as its own and absorbs it, causing thus improving the microcirculation of the blood and increasing the rate of oxidation-reduction processes, which subjectively perceived as better health, relieving fatigue and stress. The far infrared rays penetrate the body to 4-5cm, causing the maximum heating.

That's where the property is based effect of the heat treatment, which is used in physiotherapy units of domestic and foreign hospitals. On the same principle, the action is infrared sauna (cabin), where intense heat energy penetrates the body with minimal environmental temperature of the air in the cockpit, the body sweats actively in relatively mild conditions of the atmosphere - 40-60 degrees. The natural process of sweating in a pleasant, comfortable temperature ensures excellent skin care, its treatment and rejuvenation. In addition, the body temperature rises to 38.5 °C, mimicking the natural response to infection, thus, inhibits the action of pathogenic bacteria

and viruses. Another example of the device, generating directional wave far-infrared spectrum - an incubator for growing preterm infants, simulating maternal warmth.

Natural advantage of floor heating is a proven "soft" range of far-infrared radiation (90.4% of the far-infrared range with a wavelength of 5-20 microns). This means that the film floor heating and infrared heaters are a source of "soft heat" biologically optimal range. Indoor, heated thermo film created by the thermal comfort and is curative effect on the body. In addition to the far-infrared radiation, the manufacturer has a certificate that documents the formation of negative ions in the room where the film works under floor CALEO. Saturation of the air with negative ions also has a beneficial effect on the human body and contribute to cleaning the air of unpleasant odors (tobacco, paints, etc.).

Infrared heating provides uniform heating of the premises without causing internal drafts. In addition, the room is not too hot and is optimized for component moisture. Allergy is important that the room where the film IR floor neutralized static electricity.

We list the problems or conditions that are successfully corrected using far-infrared radiation: metabolic disorders, disorders of the cardiovascular activity, blood circulation disorders, diseases of the muscles and joints, colds, upper respiratory diseases, problems of excessive weight, cellulite, skin burns, nervous system disorders, immune system, trauma and post-operative period, digestive disorders, cosmetic effects.

Pathogenesis. As a result, long-term income a lot of heat in the body comes a violation of thermoregulation. The main types of temperature regulation are known to be heat production and heat dissipation. Heat buildup in the body and is chemically related to the intensity of oxidation processes. Heat transfer occurs by physical means: radiation, heat conduction and evaporation.

Coordinating role belongs sub cortical centers and the cerebral cortex.

When exposed to high temperatures, the activation of the heat transfer is accompanied by expansion of blood vessels in the skin, the acceleration of blood flow and sweating. Loss in sweat too much salt (mostly sodium chloride) and certain organic substances may cause the water-salt metabolism, blood clots, as well as disorders of the cardiovascular system and gastrointestinal tract.

To the intensity of the thermal radiation is extremely sensitive lens. Pathological changes occur when infrared rays pass freely through the cornea, chamber and absorbed moisture to some extent, of the lens. This leads to a change in its chemical composition, disruption of the relationship of metabolic processes and the resulting haze. Clouding of the lens is called a cataract.

Clinical. There are three types of heat injuries: acute, sub acute and chronic. Acute lung injury characterized by a degree of general weakness, lethargy, drowsiness, headache, nausea, rapid breathing and heart rate, sub febrile temperature. Skin is moist and cool to the touch. With an average weight, in addition to the marked complaints momentary loss of consciousness. Flushed skin and moist. Pulse and respiration teaching, the body temperature reaches 40-41 °C. Severe develop gradually or suddenly: marked loss of consciousness or psychomotor agitation, nausea, vomiting, cramps, involuntary defecation and urination, paresis, paralysis, coma, and sometimes - stop breathing. Hyperemic skin, moist (sticky sweat), hot. The body temperature of 42 °C and above, tachycardia (120-140 in 1 min), tachypnea (30-40 in 1 min), hypotension, collapse.

Sub acute thermal damage arising from a prolonged stay in a thermal radiation without violations thermoregulatory processes in the body, manifested in the dehydration, convulsions, and mixed forms. For the first characteristic temperature instability, weakness, fatigue, headache, dizziness, sweating, shortness of breath, tachycardia, oliguria, fainting and vomiting. The characteristic feature of the second form is convulsions. He occasionally appears there are painful spasms of various muscle groups, usually the legs, face, sometimes passing into general convulsions. More common in mixed form. In severe cases, find sunken eyes surrounded by dark circles, hollow cheeks, sharp nose, lips cyanotic. Skin is pale, dry, cold to the touch. Cardio-vascular system tachycardia, low blood pressure. In the blood - polycythemia, leukocytosis, elevated hemoglobin, chloropenia. Characteristic oliguria, chloride content in the urine drastically reduced.

For chronic thermal injury is characterized by a number of syndromes, or a combination thereof.

Neurasthenic syndrome is characterized by dystopia autonomic nervous system. Anemic syndrome is accompanied by a moderate decrease in the number of red blood cells, white blood cells, hemoglobin, and reticulocytosis.

Cardio-vascular system tachycardia, labile pulse, shortness of breath, reduced the maximum arterial pressure. On ECG - signs of myocardial dystrophy. There have also been dyspeptic disorders, dull pain in the epigastric region after eating, you may experience gastritis, enteritis, colitis.

The impact of thermal radiation to the eye leads to the development of cataracts. It is noted cataract. Complaints of patients are reduced to a "fly" or "smoke" before the eyes, have a desire to brush away the stain, rub your eyes. Poliopii phenomenon can occur when one eye sees the patient a few items, especially luminous (a few light bulbs, moons, etc.). Such cataracts start to develop at the posterior pole and are discs or rings located between the bag and the cleavage area. When biomicroscopic study characterized colored iridescence. The latent period may last 10 years or more.

Treatment. Performed according to the severity of the disease. Showing gidroprotsedury. In mild cases - a warm shower (26-37 °C) for 5-8 minutes, when expressed forms - bath (29 °C) for 7-8 minutes, followed by a shower (26 °C). In the absence of shower and bath use wet wraps for 10-15 minutes, cold on his head, drinking plenty of fluids until their thirst. The patient needs complete rest. According to the testimony prescribed sedatives and drugs affecting the cardiovascular system. In injected isotonic sodium chloride, glucose, plasma. Showing oxygen therapy, symptomatic treatment.

In extremely severe conditions shall take all appropriate resuscitation.

Favorable prognosis in the absence of residual effects in the form of disorders of the nervous system (such as paresis, paralysis, intellectual disorders, etc.).

Expertise of disability. For the period of treatment, the patients are released from work in conditions of thermal radiation. After a full recovery, they can continue to work in the same place.

If there are residual functional changes in the cardiovascular, nervous system, eyes, the patient must go to work, not related to exposure to intense radiant heat until full recovery. If after

treatment remain persistent functional impairment, no further work under intense heat radiation is contraindicated.

Prophylaxis. To prevent development of the disease is necessary to carry out actions of sanitary measures aimed at improving the microclimate in hot shops, rational work and rest, the use of personal protective equipment. Important compliance drinking and diet, providing recovery of water-salt balance.

Microclimate parameters of production facilities depend on the thermophysical characteristics of the process, climate, seasons, conditions of heating and ventilation. Of fundamental importance in the rules has separate regulation of each component of the microclimate temperature, humidity, air velocity.

The group of sanitary measures are aimed at reducing the intensity of the heat radiation and heat from the equipment. Effective means to reduce the heat release is a cover of hot surfaces and vapor and gas pipeline insulation materials (glass wool, asbestos mastic asbotermitom etc.), sealing equipment, the use of reflective, heat sink and heat-shields, the device ventilation, use of personal protective equipment.

Necessary to conduct preliminary and periodic medical examinations of personnel. Periodic medical examinations are carried out with the participation of the therapist and an ophthalmologist at least 1 time in 24 months.

Medical contraindications for employment in conditions of intense heat radiation are:

- 1) expressed eye disease, reduced visual acuity, cataracts;
- 2) severe autonomic dysfunction;
- 3) chronic bronchopulmonary apparatus with frequent exacerbations;
- 4) chronic, often relapsing skin diseases, gastro-intestinal tract.

#### Conclusion

At a temperature of 18 °C a person can work with the normal performance. During mobile operation at temperatures above 20 °C, productivity declines. Temperature of 25 °C at a relative humidity of 70% reduces the efficiency and the temperature of 30 °C at a humidity of 80% makes the job very difficult, from which increased fatigue, the efficiency is reduced by 35% compared to the initial phase.

Prolonged work in such climatic conditions hazardous to health. In hot shops to either automate the heavy physical work, or use spot cooling to a temperature corresponding to the normal work of a man.

Ways to reduce heat radiation - reducing heating machine or improvement of thermal insulation hot surfaces - to reduce the intensity of thermal radiation machine, bare light planes can reduce the layer of aluminum foil or a clean aluminum filler (aluminum putty cannot be used to cover the high temperature heating elements as it reduces the coefficient emission by 50% compared to the enamel) - use of the cover or barrier between the source of thermal radiation and infrared

person "shadow"), such as absorbing (asbestos, glass, water-cooled, chain, valves, metal grids) or reflective screens (aluminum sheets or foil glued to asbestos plate), which reflect the 90 - 95% of infrared rays, aluminum putty represents two thirds of the infrared - cooling the working due to supply and blow dry and cool air at a certain speed, depending on the intensity of heat radiation, water curtain minimum thickness of 10 mm, but when using it increases the likelihood of increasing the relative humidity in a room that has a negative effect on the working (increased fatigue) - use of personal protection from radiation (protective clothing).

The far infrared rays normalizes metabolism and correct the cause of the disease, and not just the symptoms. The studies on the use of penetrating far infrared radiation continues around the world.

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#### Резюме

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#### ЖЫЛУЛЫҚ СӘУЛЕНІҢ АДАМ АҒЗАСЫНА ӘСЕРІ

Жұмыста жылулық сәуленің адам ағзасына әсері, инфрақызыл сәуленің әсерінен болатын негізгі кәсіби ауру түрлері, профилактикалық жұмыстар қарастырылған. Жылулық сәулені төмендету тәсілдері ұсынылған.

Кілт сөздер: жылулық сәулелену, инфрақызыл сәуле, жылулық сәуле әсерінен кейінгі адамның жұмысқа қабілеттілігі, халықтың жылулық әсермен зақымдалу маңызы, жылулық сәулені азайту тәсілдері.

## Резюме

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### Воздействие тепловых излучений на организм человека

В работе рассматривается воздействие тепловых излучений на организм человека, основные виды профзаболеваний от действий инфракрасных излучений, профилактические работы и т.д. Предложены способы уменьшения тепловых излучений.

Ключевые слова: излучение тепла, инфракрасное излучение, трудоспособность человека после воздействия теплового излучения, сущность поражения людей тепловым действием, способы уменьшения теплового излучения.

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