An estimation of change of parameters of indoor microclimate during term of exploitation of building and engineering systems*

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Abstract. *The lifetime of various buildings has a different age, which is from 25 to 50 years, and after additional studies and examinations may be extended on longer term. The lifetime of engineering systems, depending on their type and purpose is 10 to 25 years, and in some cases much more. Parameters of microclimate, on which the building is designed, do not include lifetime or building envelope or engineering systems. However, there are aging and sometimes destruction of some of the elements that negatively affect the change in the parameters of the microclimate sanitary norms during the operation of the building and its engineering systems. Estimation of parameter changes of indoor microclimate during the life of the building engineering systems will monitor their fluctuations and affect their adjustment to maintain required parameters.*

Keywords: climate; systems of life-support; microclimate parameters; man; health

1. Formulation of the problem.

Providing micro-climatic parameters in rooms of buildings for normal operation is particularly important problem whose solution can maintain working capacity of a human at a high level during the entire working time. Support for the required parameters of the indoor microclimate should be carried out throughout the life of the building and systems engineering on a background of the progressive aging. Today in Ukraine there are no methodologies for evaluating and predicting climate in the room, which would allow them to ensure the maintenance at the right level according to

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sanitary norms. Thus, maintaining of standard parameters solution of microclimate indoors for high working capacity of human throughout the life of the building and engineering systems through evaluation and prediction is important and relevant.

2. Analysis of recent research and publications.

There are a lot of different studies, both in Ukraine and abroad [1 - 14] in the area of research of indoor environment of various buildings and its impact on human health and working capacity. The best-known scientists in creating microclimate and its study are V.N. Bogoslovskiy, O.Fanher, L. Banhidi and others. All studies, calculations in the design of the building and life-support systems are reduced to the estimation and forecasting microclimate for the initial date of their operation due to difficulties in sustainable support of microclimate because of multifactor depending on various factors. This approach leads to bias of the prediction and evaluation of microclimate throughout the life of the building and engineering systems.

3. Selection of still unsolved problems.

This article concerns the task to identify ways to address the problem of estimating the parameters of the microclimate in the room during the life of the building and engineering systems.

To identify and classify the major factors and aging the heat building envelope and systems engineering and their impact on the parameters of the microclimate in the room.

4. Aims.

To estimate the changes of parameters of microclimate in room during the term of exploitation of building and engineering systems by model researches. The interest of this results are temperature measurements of indoor air and on indoor and outdoor surfaces of enclosing structures which have defects. We estimate evaluation of microclimate changes with pyrometer.

5. Statement of the basic material.

When designing a new building or reconstruction and development of engineering systems the main task, which is solved, is to provide comfortable living conditions of people or driving technology process. That heat shielding building envelope and operation of heating, ventilation and air conditioning should ensure the regulatory parameters of the microclimate, which must be maintained constant at variable parameters of climate, internal and external thermal influences of various factors. Initially, the building and operation of life support systems compliance with hygiene standards is carried out at a level that is accepted in the project, but the

situation totally varies in service. The influence of various factors lead to aging of materials of building structures, elements of sustenance than reduced their properties and working functionality. These changes also lead to lower availability of microclimate in the premises of the building.

Factor which lead to a decrease in operating properties of external enclosing structures and engineering systems which are associated with exposure of physical and moral deterioration.

According to [15] inspection of the technical condition of buildings and engineering structures, and monitoring of their technical condition are elements of supervision over them. According to survey results the level of compliance is determined with the terms of the normal and safe operation and provides input for the implementation of measures to effectively care for their technical condition.

Examination of technical condition of buildings can be carried out as scheduled and unscheduled.

A survey of the building sets the technical condition of structural elements. In assessing the technical condition of the building and its elements must take into account the impact of technical equipment of buildings and facilities and the mutual influence of the natural and man-made environment.

The technical condition of the building is determined on the basis of established technical condition of individual structural elements.

Based on the findings of the technical condition of the building is necessary to assess the state of the indoor environment of the building, and perhaps predict their period to the following planned or unplanned inspection. It is necessary to carry it out because of change microclimate leads to changes of heat and humidity and air modes of both external walling buildings and internal environment.

Define the basic defects of external enclosing structures and their influence on the change of microclimate in the room.

A variety of designs and materials which is used in the construction of external protecting designs causes typical damage, defects and obsolescence of materials.

In the structures, which are made of concrete and reinforced concrete main defects are:

– cracks and excessive deformation from the power influence and corrosion origin;
– fragmentation, peeling, cracks in compressed concrete;
– exposure, bulging, displacement, achievement of elastic strength and split of armature, violation of it's adhesion with the concrete;
– corrosive damage of concrete, armature, connecting embedded parts;
– damage from alternate wetting, freezing and thawing;
– thermal deformations at distances between temperature precipitation seams to conditions;
– technological defects (shrinkage cracks in concrete separation, inadequate protective layer of concrete, decompaction in working seams, etc.);
– mechanical, fire damage and others.

The main defects and damage of a stone and reinforced buildings and engineering structures are cracks, delamination, bulging, weathering, mechanical damage (including placement of new strobes and holes), corrosion of masonry and armature, technological defects. The most common and widespread types of defects and damage wooden structures are:

- wetstate (or periodic wetting) of wood;
- change of the natural color of wood;
- unacceptable deformation of structures and it's elements;
- destruction of wood by pests;
- corrosion of metal parts;
- destruction from the effects of chemical aggressive environments;
- technological defects;
- cracks and separation. The main defect of roofing and hydro insulations is leak as a result of the following:
- mechanical action on the roof or waterproofing ;
- abuse of density of connections between the individual elements or roof waterproofing;
- atmospheric corrosion of roof elements;
- corrosion of waterproofing elements;
- appearing of cracks in materials of roofing or waterproofing through tensile stresses in the material of uneven settling at the base.

Analysis of the defects that may occur in the outer protecting structures shows that for estimation of the parameters of the microclimate they can be classified by the following way:

- defects associated with through damage to the fence;
- defects associated with partial damage to the fence, which led to a reduction in thickness;
- defects that led to the obsolescence of the construction materials of outer fence.

During the through damage of outer fence the change of parameters of microclimate has the most influence of heat and mass exchange and air modes. With this kind of damage temperature, t humidity and speed of internal air changes the most under the external climatic factors.

During the partial damage of the outer fence, where the thickness is reducing, there are the largest exposures of parameters of the microclimate such as temperature and humidity of the internal air, temperature of the inner and outer surfaces.

Obsolescence of construction materials of outer fence reduces the efficiency of their thermal characteristics, which in turn leads to a change of heat and mass exchange and air modes indoors and accelerates aging.

Any changes of microclimate in the premises lead to changes in normal operation of the human body, that is a violation of its heat balance, which results overheating or overcooling. In this case working capacity of human is reduced.

To confirm the influence of defects of enclosing structures of building on parameters of the microclimate the examination was conducted at the objects of various purposes. A survey was conducted in administrative building and bakery at the winter.

Fig. 1 shows a fragment of a wall of an office building with vertical crack. With external review of cracks it can be seen that crack is floated by mortar and there is no through-its expansion.

A survey of the same crack of the building wall has hold by thermal camera 'testo 875-2'. The survey results presented in Fig. 2.

Fig. 1 Detail of the building wall with a crack

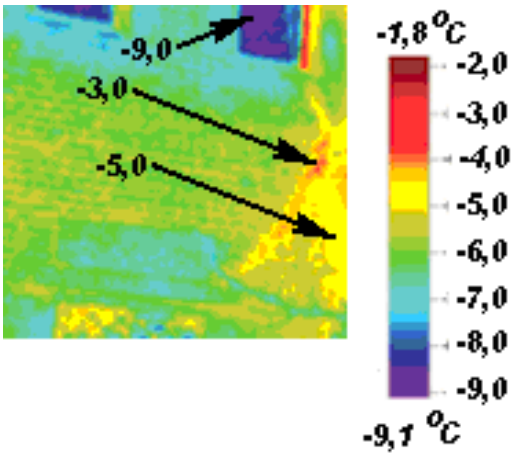

Fig. 2 Thermogram detail of the building wall with a crack

The analysis of the received picture (Fig. 2.) shows that violation of integrity of a structure of an external protection can't carry out the functional purpose on heat, humidity and air protection of the internal environment of the building even during its repair. Apparently from the thermogram the vertical crack on a wall of the building has rather high temperature ranging from $-3\ ^oC$ to $-5\ ^oC$, and the lowest temperature is $-9{,}1\ ^oC$. From here we draw a conclusion that the temperature pressure of this site of a wall grew by 1,2 - 1,3 times, thus temperature on an internal surface also has to accept size less standard that leads to increase in size of heat exchange of the person indoors.

As a result of inspection of a bakery the defects connected with partial damage of external protections and misoperation and operation of life support systems were found. Examinations were conducted by means of a pyrometer.

Cracks in structures of walls and a ceiling, partial destruction of a bricklaying are carried to partial damages on a bakery. On an internal surface of walls and a ceiling, in connection with high exudation of moisture, in mixing and cooling shops and misoperation of systems of forced-air and exhaust systems of ventilation moisture loss is recorded.

The research results of thermal and humidity parameters on the inner surfaces of enclosing structures presented in Table 1.

In places with cracks in the external protecting structures the temperature on border of a crack has temperature which is lower on 1 - 2 ^{o}C than temperature surface wall without damages.

According to the obtained data we draw a conclusion that damages of the external protecting structures leads to change of parameters of a microclimate towards their decrease.

Table 1

Temperature and humidity indicators

Inspection place location	Indoor temperature	Indoor humidity, %	The temperature on the inner surface of the outer wall, ^{o}C		The temperature on the inner surface of the ceiling, ^{o}C	
			Dry area	Wet area	Dry area	Wet area
Mixing shop	23	77…90	20,2…20,4	17,4…17,6	20,0…20,2	17,0…17,2
Cooling shop	16	60	18,0…18,2	16,2…16,4	16,0…16,2	12,3…12,4

According to the obtained data in the first case without measurement of temperatures on an internal surface of the protecting structure and vice versa in the second case without measurement of temperatures on an external surface of the protecting structure it is possible to assume that the obtained data can have close values. But for an adequate assessment of change of parameters of a indoor microclimate during the term of operation of the building and engineering systems taking into account their obsolescence and damages it is necessary to take at the same time measurements of the heat and humidity parameters from the internal and external parties of the protecting structures.

The impact on the parameters of indoor climate have defects associated with continuous or partial damage to the outer fence, and obsolescence of construction materials.

Conclusions.

On the stated material of the article in which solutions of assessment problem of parameters of an indoor microclimate during the term of operation of the building and

engineering systems are given, the main conclusions and recommendations consist in the following:

1. The assessment of parameters of an indoor microclimate during the term of operation of the building and engineering systems is carried out due to planned and unplanned inspections of technical condition of buildings and an assessment of a condition of a microclimate or its forecasting;

2. The defects connected with through or partial damage of an external protection, and also obsolescence of their constructive materials indoors have influence on microclimate parameters;

3. The obsolescence or defects and damages of the external protecting structures leads to change of parameters of an indoor microclimate, which in turn influences on health and working capacity of the person.

4. The results can be implemented in future investigation of human thermal comfort. There are plans to create new model of human behavior which is influenced with temperature.

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