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INCREASE AERODYNAMIC AND THERMAL CHARACTERISTICS WALLING WITH VENTILATED CHANNELS

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The construction of wall panels agricultural buildings with more sophisticated aerodynamic and thermal performance. The data of experimental research and the method of calculation of frame structures with ventilated channels.

Building envelope, ventilation, turbulence, hydrodynamic calculation.

In many regions of Ukraine in the operation of buildings significantly increases the moisture content of external walling, which results in increased heat loss during the heating season.

In the existing housing stock Ukraine share of large buildings is significant. In modern construction using prefabricated walling significantly decreased, but they still occupy a significant niche. Relevant research is aimed at walling improve their thermal properties, particularly in identifying the causes accumulation of moisture deep in the enclosure in the annual life cycle of buildings [1].

The purpose of research – to establish the relationship of changes in humidity enclosure in the area of phase transition depending on the placement of the front of a phase transition in the thickness of a homogeneous material.

Materials and methods research. The processes of diffusion of water vapor in the enclosure can be complicated molar transfer of moisture in the air. Parameter, which is responsible for the ability of moist air to keep water vapor - Se is the analogue of the specific heat of air in the heat transfer (h / kg • Pa), and is given by:

$$C_e = \frac{622 P_0}{\left[P_0 - \frac{\varphi}{100} E_s \right]}, \qquad (1)$$

where P_0 - barometric pressure,φ; - relative humidity of ambient air,% E_S - water vapor pressure at a given temperature, Pa.

Specific paroyemnist depends on the relative humidity in the pores of the material walling and sorption isotherms determined differentiation [2,3]:

$$\varepsilon_0 = 1000 \frac{\partial \omega}{\partial \varphi} \qquad (2)$$

where ω - gravimetric moisture sorption material; φ - relative humidity in the pores of the material.

The analysis showed that one of the promising methods to prevent condensation of water vapor in the thick outer walling is placing them in ventilation channels. However, existing models of structures ventilated walls have a drawback - in aid of the air used for heat recovery in ventilated structures is lead airflow from the walls of the channel. Because vouchers phenomena only living section of the ventilation air flow channel covered. The separation vortex flow is accompanied by movements that occur mainly in the field changes direction channel. In the channels of external protections similar design air flow is much less theoretically possible for this size living area crossing the channel.

Results. The technical solution to the problem is to improve the constructions of ventilation channel in aerodynamic terms. We proposed ventilated channel that is different from the basic fact that the U-base and discharge areas at 120 ... 130 ° to the main plot. In addition, their connection to the main, vertical sections Eased (Figure 1), which reduces the vouchers phenomena and, consequently, to a marked reduction in aerodynamic losses.

In order to assess the effectiveness of the proposed design ventilated channel were conducted experimental studies of wall panels in a special climate systems research institute "KIEV ZNDIEP."

This package allows you to artificially create external and internal thermal conditions premises. It consists of three sections - external, internal and operator. In the outer compartment of climatic parameters set played outside air during the heating season. In the inner compartment reproduced temperatures and humidity of the internal air livestock premises. As a carrier-compartment housed test equipment

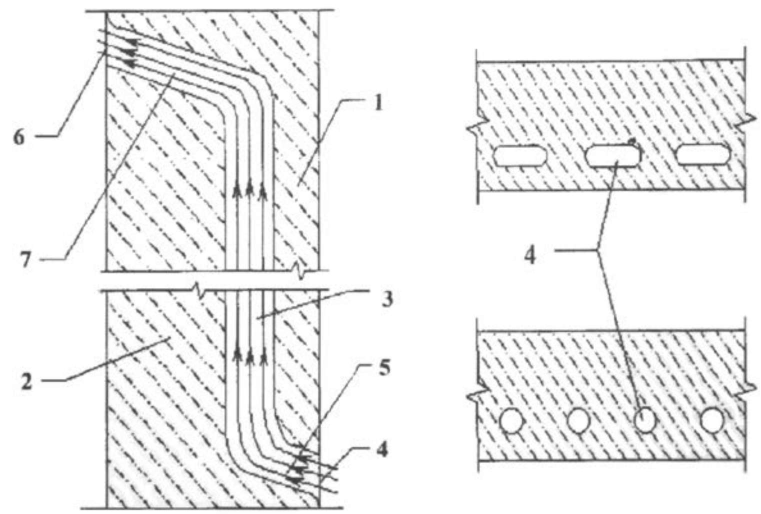

Fig.1. Single layer ventilated panel of external fences and natural with artificial (mechanical) ventilation: 1 - external protective and decorative screen 2 - internal bearing layer 3 - ducts, 4 - inlet openings 5 - inclined inlet area; 6 - outlet, 7 - sloping plot diverter.

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The outer compartment climate chamber based at termobaroklava KTBV-8000/2, which has a powerful refrigeration unit capable of providing standardized ISO values ambient air temperatures during the heating season.

The temperature in the outer compartment of the climate chamber maintained automatic control system to within ± 1,5 ° C, and in the mid to within ± 1 ° C. Moisture in the warm compartment cameras automatically maintained to within 3%.±

In warm compartment maintained complex climatic parameters air characteristic of livestock buildings: temperature +14 ± 1,0 ° C; relative humidity of 75 ± 3,0%). In the refrigerator compartment winter climate created outside air, temperature -19 ± 1,5 ° C; relative humidity of 79 ± 3,0%).

The experiment was conducted for four different frame structures: solid wall (A); with a channel near the inner surface of the fence (B); with a channel near the outer surface of the enclosure (B) and channel location in the center of fences (C). Location ventilation channels in the thick envelope shown in Figure 2.

We studied the following conditions:

• Ventilation segments of preheated air;

• natural ventilation outside air;

• unventilated channels (fences, sealed channels).

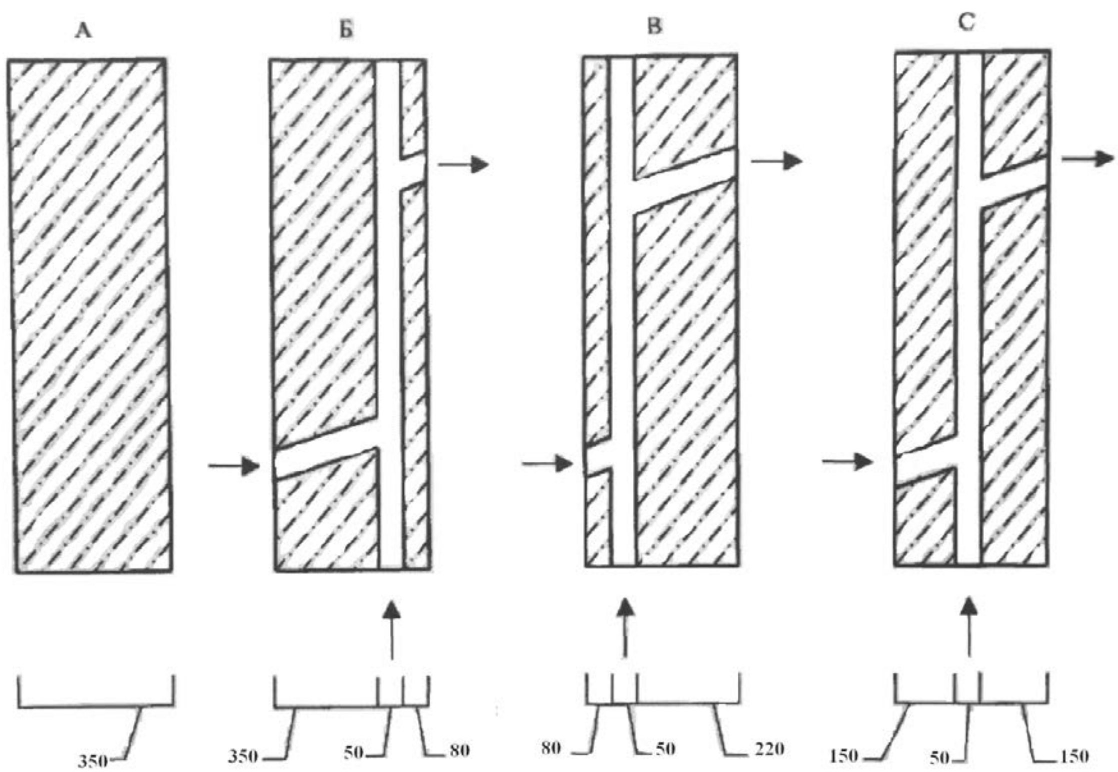

Fig.2. Structures studied fragments of walling: A - control area; Б - the channels close to the inner surface of the enclosure; B - the channels close to the outer surface of the enclosure; C - channels in the heart of the fence.

As a control regime to assess thermal characteristics fences taken data from fence without channels (option A).

When conducting field trials thermophysical used tools and equipment in accordance with GOST 26254-84. Temperature measurements were carried out using copper-konstantanovyh thermocouples (-50 ... +150 ° C, ± 0,2 ° C) that are attached to the inner and outer surface of the investigated fences (Figure 3). The obtained experimental results in the processing period average temperature observations are rounded to 0,1 ° C. The measurements were conducted heat flux density sensor heat flow transducer TAP-0.11.13.14.00 (up to 20,000 W / m 2, ± 5%). The results of the measured values of heat flow okruhlyuvalys to 0.1 W / m2.

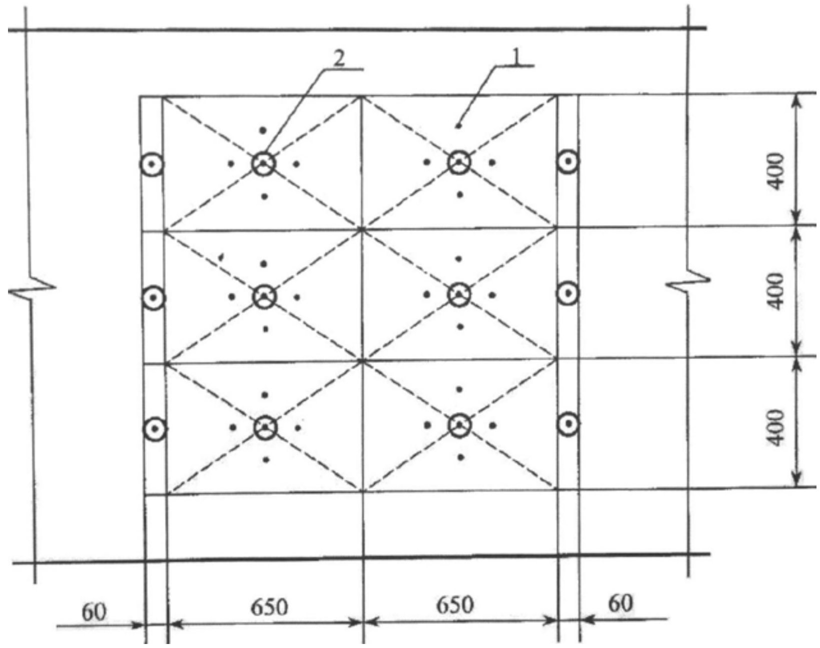

Fig. 3. Location of sensors: 1 - temperature sensor 2 - sensor heat flow transducer.

Thermocouples and heat flow through multipoint switches are connected to an electronic voltmeter V7-21A by which determined thermo emf each sensor. The relative humidity was determined psychrometers VM-4M.

To select the optimal layout of sensors that take into account the structural features of the studied fencing, a pilot survey of surface thermal panel with a pyrometer. It revealed thermally homogeneous area and location of heat-conducting particles, their size and configuration.

Based on the analysis of experimental studies have found that the ratio of heat transfer resistance for the standard panel design to the experimental level 0.145 ... 0.398 m2 K / W. This result strongly suggests that preference should be given ventilated channels with improved aerodynamic performance. Experimental data were supplemented by theoretical calculations.

Assuming that the ventilation duct has a cylindrical shape - the motion of incompressible viscous medium can be described by equations:

• flow continuity equation:

$$\frac{\partial w}{\partial z}+\frac{\partial \upsilon}{\partial r}+\frac{\upsilon}{r}=0; \qquad (3)$$

• equation of the fluid - Navier - Stokes:

$$\frac{\partial \upsilon}{\partial \tau}+w\frac{\partial \upsilon}{\partial z}+\upsilon\frac{\partial \upsilon}{\partial r}=-\frac{1}{\rho}\frac{\partial \rho}{\partial r}+\frac{\partial}{\partial z}[v_{eff}(\frac{\partial \upsilon}{\partial z}+\frac{\partial w}{\partial r})]+\frac{1}{r}\frac{\partial}{\partial r}(2rv_{eff}\frac{\partial v}{\partial r}); \qquad (4)$$

$$\frac{\partial w}{\partial \tau}+w\frac{\partial w}{\partial z}+\upsilon\frac{\partial w}{\partial r}=-\frac{1}{\rho}\frac{\partial \rho}{\partial z}+\frac{\partial}{\partial z}(2rv_{eff}\frac{\partial w}{\partial z})+\frac{1}{r}\frac{\partial}{\partial r}[rv_{eff}(\frac{\partial w}{\partial r}+\frac{\partial \upsilon}{\partial z})]; \qquad (5)$$

• heat transfer equation in the fluid stream:

$$\frac{\partial t}{\partial \tau}+\upsilon\frac{\partial t}{\partial r}+w\frac{\partial t}{\partial z}=\frac{1}{r}\frac{\partial}{\partial r}[r(\frac{v}{\mathrm{Pr}}+\frac{v_t}{\mathrm{Pr}_t})\frac{\partial t}{\partial r}]+\frac{\partial}{\partial z}[(\frac{v}{\mathrm{Pr}}+\frac{v_t}{\mathrm{Pr}_t})\frac{\partial t}{\partial z}]; \qquad (6)$$

• heat equation in the wall of the channel:

$$\frac{\partial t}{\partial \tau}=a(\frac{1}{r}\frac{\partial t}{\partial r}+\frac{\partial^2 t}{\partial r^2}+\frac{\partial^2 t}{\partial z^2}) \ . \qquad (7)$$

To describe turbulent transport except Navier - Stokes and heat transfer to equations 3 ... 7 attached equation turbulence kinetic energy k and its dissipation velocity, namely:

• turbulence kinetic energy equation:

$$\frac{\partial k}{\partial \tau}+w\frac{\partial k}{\partial z}+\upsilon\frac{\partial k}{\partial r}=\frac{1}{r}\frac{\partial}{\partial r}(r(v+\frac{v_t}{\mathrm{Pr}_k})\frac{\partial k}{\partial r})+\frac{\partial}{\partial z}((v+\frac{v_t}{\mathrm{Pr}_k})\frac{\partial k}{\partial z})+G_k-\varepsilon-D_k; \qquad (8)$$

• equation for the rate of energy dissipation:

$$\frac{\partial \varepsilon}{\partial \tau}+w\frac{\partial \varepsilon}{\partial z}+\upsilon\frac{\partial \varepsilon}{\partial r}=\frac{1}{r}\frac{\partial}{\partial r}(r(v+\frac{v_t}{\mathrm{Pr}_\varepsilon})\frac{\partial \varepsilon}{\partial z})+\frac{\partial}{\partial z}((v+\frac{v_t}{\mathrm{Pr}_\varepsilon})\frac{\partial \varepsilon}{\partial z})+\frac{\varepsilon}{k}C_{1\varepsilon}G_k-\frac{\varepsilon}{k}f_\varepsilon-R_\varepsilon. \qquad (9)$$

In turbulent flow regime in the heat transport equation (6) is introduced Rrt Prandtl number, which for different models of turbulent viscosity is defined differently. For standard k- - model turbulent Prandtl number remains constant, or determined by empirical dependencies. For RNG k- - model turbulent Prandtl number presented solution transcendental equation [5]:

$$\left|\frac{\mathrm{Pr}_t^{-1}-1.3929}{\mathrm{Pr}^{-1}-1.3929}\right|^{0.6321}\left|\frac{\mathrm{Pr}_t^{-1}+2.3929}{\mathrm{Pr}^{-1}+2.3929}\right|^{0.3679}=\frac{\nu}{\nu_t}. \qquad (10)$$

To determine the Prandtl number for the kinetic energy of turbulence using the relation:

$$\left|\frac{\mathrm{Pr}_t^{-1}-1.3929}{0.3929}\right|^{0.6321}\left|\frac{\mathrm{Pr}_t^{-1}+2.3929}{3.3929}\right|^{0.3679}=\frac{\nu}{\nu_t}. \qquad (11)$$

For RNG k- ε - the value of Prandtl model for kinetic energy and its dissipation rate for the same for other models of the dynamics of turbulence is determined usually empirically.

Conclusion

The design of the panels with ventilated channel has several advantages in aerodynamic and in thermal terms. Hydrodynamic calculation of ventilation channels walling should be performed based on flow turbulence and its dissipation.

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