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Energy-Saving Solution in The Heating System of Buildings

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Abstract

Considered by one of the solutions of the program "Energy saving for 2010-2020, for the enterprises of Kursk and Kursk region", which consists in the local reducing heat loss to the environment from the room by changing the conditions of heat exchange between apparatus of heat exchange of the heating system and the inner surface of the outer fence. Are given the fundamental structural solution - device additional of local thermal protection of external walls in heating buildings.

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Keywords: Energy efficiency, heat loss, heating system, biosphere systems, heat exchanger, reflective heat shield panel.

1. Introduction

Developed on the instructions of the government of Kursk region in collaboration with the staff of the Center for energy-saving equipment and materials, formed on the basis of the department "Heat and ventilation" under the leadership of the rector SWSU Sergey Emelyanov "Program of energy saving for 2010-2020, for the enterprises of Kursk and Kursk region" contains a list of collective measures for the implementation of energy-saving technologies and equipment. Energy saving strategy consists of a complex of long-term high-cost, average cost and priority actions and for the average cost of priority measures which will allow to improve the reliability and efficiency of the heat sources and heat networks, intrahouse engineering systems, automated heating systems in buildings to reduce the heat transfer agents, hot and cold water.

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One solution to the "Program" is reduce heat loss to the environment when heat supply of building, especially with the location apparatus of heat exchangers heating of system near the inner surface of the outer wall of the room.

In the framework of the legislation since 1995 in accordance with Russian code SNIP 23-02-2003 "Thermal protection of buildings" significantly tightened requirements for the thermal resistance of enclosing structures of buildings. In accordance with the normative document is necessary that thermal-technical performance of building envelopes provide not only execution sanitary conditions, ie, conditions are not condensation on the inner surfaces of enclosures, but also the principles of energy saving. For the climatic conditions of Kursk and Kursk region the value of thermal resistance of walls, ensuring no condensation is 1,26((m^2˚C))⁄Vt, and according to new norms should be 2,95((m^2˚C))⁄Vt, and it is expected to reduce energy consumption by 40%.

To ensure these requirements for thermal protection is necessary to implement measures to optimize building structures (use walling with effective insulation and construct (design) of windows with a higher coefficient of thermal resistance and breathability). In this regard, was done works to energy-technical survey of existing housing in Kursk, namely a series of houses 1-447s-11, 1-464A-9, 91-014/1.

Implementation of methods of thermal sanctions allows to eliminate excess heat loss and reduce the cost of heat on the maintenance of microclimate in buildings considered series. Annual savings of thermal energy after the carrying out measures by additional insulation exterior fences for heating 1 living space and in general on fund is presented in the table. The average payback period of works of thermal insulation walling is 20 years, but with an increase in the growth of tariffs for thermal energy, these works will be required and will be have demand [1

Table 1. Technical and economic parameters of additional thermal insulation of external fencing of residential buildings

A series of residential buildings	Specific annual savings of heat, $[\mathrm{Gcal/m^2}]$	Number of houses	Specific expenses for additional insulation, (rubles), $[\mathrm{th.rub/m^2}]$	Heat savings in general fund, [Gcal]
Series 1-447c-11 three-storey	0.02	167	1.55	7092
Series 1-447c-11 four-storey	0.03	145	1.54	20453
Series 1-447c-11 five-storey	0.03	307	1.54	54130
Series 1-464A-9	0.06	226	1.54	75798
Series 91-014/1	0.19	172	1.6	184721

Studies of character of heat loss by area of the outside fence showed that the most intense heat removal from the heated space is performed locally at the site of installation heat exchange apparatus of the heating system, which is preferably located near the inner surface of the outer walls and under the sill of the window glazing.

In this case, the process heat exchange - transfer heat from a heat exchange apparatus heats the internal air is uniform in terms of volume of heated space and the air gap of wall bettween convective heat exchange to obtain the thermal radiation from the body of a heat exchanger, as well as the amount of heated air gap between it and the inner surface of the outer wall is significantly less than the volume of heated air in the heated room, the air gap is rapidly heated, giving heat to the outside wall and further, as the heat losses to the environment.

Sophisticated heat transfer is described by a system of equations consisting of equations of energy, motion and continuity, to which is added the condition of unambiguity.

Energy equation of single component air environment absorbing, emitting and dissipate energy has the form [1]

$$\mathrm{div}\overrightarrow{q_T} + \mathrm{div}\overrightarrow{q_K} + \mathrm{div}\overrightarrow{q_r} = 0 \qquad (1)$$

Where q_T , q_K, q_r - respectively the vectors of density heat flux by conduction, convention and radiation

Heat transfer, molecular and turbulent, thermal conductivity in the boundary layer of contact the outer surface of the contact heat exchanger and the indoor air is described by the Fourier series:

$$q_T = -\lambda_T \nabla T \quad (2)$$

here T - the time-averaged local value of temperature in the boundary layer;

λ_T - Coefficient of turbulent heat transfer, thermal conductivity in the boundary layer;

Convective transport of enthalpy

$$q_K = \rho c_P \omega_X T \quad (3)$$

where ρ,c_P,ω_X - the density, heat at constant pressure and speed of air movement in the boundary layer upon contact with the outer surface of heat exchange apparatus.

Radiative heat transfer is approximately defined by the dependence

$$q_P = -\lambda_P \nabla T \quad (4)$$

where $\lambda_P = \frac{16\,\sigma_0 T^3}{3\,\overline{\alpha}}$ - the radiation coefficient of thermal conductivity;

here σ_0 - Stefan-Boltzmann constant

$\overline{\alpha}$ - Average heat irradiation coefficient in the boundary layer.

The total flow is determined the sum of flows carried by thermal conductivity, convection and radiation, ie,

$$q = q_T + q_K + q_r \quad (5)$$

At the same time, considering the absorbing non-isothermal environment medium as limited plane-parallel walls (outer surface of the heat exchange apparatus and the inner surface of the outer surface of the building-wall), we have

$$q = \frac{T_0\left(T_1^4 - T_2^4\right)}{\frac{1}{A_1} + \frac{1}{A_2} - 1 + \frac{3\overline{\alpha}l}{4}} \quad (6)$$

Where T_1 and T_2 as well as A_1and A_2, the temperature and the absorption coefficient, respectively, surfaces of the walls and the thermal apparatus;

l - Distance between the surfaces.

Then the temperature distribution on the inner wall surface is defined as

$$T_2^4 = T_1^4 - q\frac{3}{4}\frac{\overline{\alpha}}{T_0}\,l \quad (7)$$

Therefore, to reduce the temperature (T_2) of the inner wall surface and thus reduce the loss of heat by reason of conductivity through the thickness of the outdoor construction fence must on expression (7) to increase the summand $q\frac{3}{4}\frac{\overline{\alpha}}{T_0}\,l$,, i.e. provide more heat in a heated room, eliminating him from the cavity under the windowsill.

The distance between the heat exchange apparatus - heating element and the outer wall surface limited SNIP [2], as well as the design of the room. That is why, energy-saving actions can be carried out in two directions. The first - increase in the average heat irradiation coefficient (¯α) due to turbulence in the boundary layer of air environment between heat exchange apparatus and the wall. The second - increase in total heat flow (q) by increasing the radiation component, for example, by setting on the inner wall surface of the reflecting structure.

It is proposed device reflective baffle plate for additional local thermal protection of outdoor fences, made, for example, made of polished aluminum, as having a low coefficient of absorption E - from 0.04 to 0.06 [3] that virtually eliminates heat transfer through the outer wall in the form of radioactive (q_P) total flow (q) heat exchanger. On the surface 1 of the baffle plate longitudinally by height is made in pairs 2 curvilinear grooves 3. Tangent one of the cam grooves 4 3 2 of each pair has a direction to clockwise direction, and the other 5 tangent of the curved grooves 3 of this pair 2 has a direction counter-clockwise [4]. In this case, the location of the curvilinear grooves 3 done for each section 3 6 for at least three levels 7. As the income that the heat transfer agent in the heat exchange apparatus of the heating system, the total heat flux (q) is evenly distributed heating the air as the total internal volume of the entire room, and an air layer between the outer a heat exchanger surface and the inner surface of the outer wall. In connection with a small distance between the heat exchange apparatus of heating system and the inner surface of the outer wall, as compared with the volume of the heated space in the air gap and the air is heated rapidly emerging as a result of the density difference, begins to move on the curvilinear grooves 3 located on surface 1 reflective baffles from the bottom up in the boundary layer 8. When moving in the boundary layer 8 at the lower level 7 on one 4 from pairs 2 of curvilinear grooves 3 sections 6 airflow section twists clockwise direction, simultaneously on the other 5 of the pair 2 of two curvilinear grooves 3 twists airflow direction counter-clockwise.

As a result, on the output from the lower level 7 observed counter movement of the involute microflows rising up swirling air, which leads to formation of microexplosions and the sharp turbulization of the boundary layer [5]. This transition from the laminar flow of air in the boundary layer 8 to the turbulent carried out at all levels 7 of surface 1 of the reflective baffle, which ensures the elimination of loss of heat convective component(q_k) of the summary flux (q) of heat exchange apparatus, i.e. not heated convectively (due to the increased thickness turbulence moving of boundary layer) surface 1 of reflective baffle and accordingly, inner surface of the outer wall, and the heat is transferred to the heated air into the interior volume of the heated space.

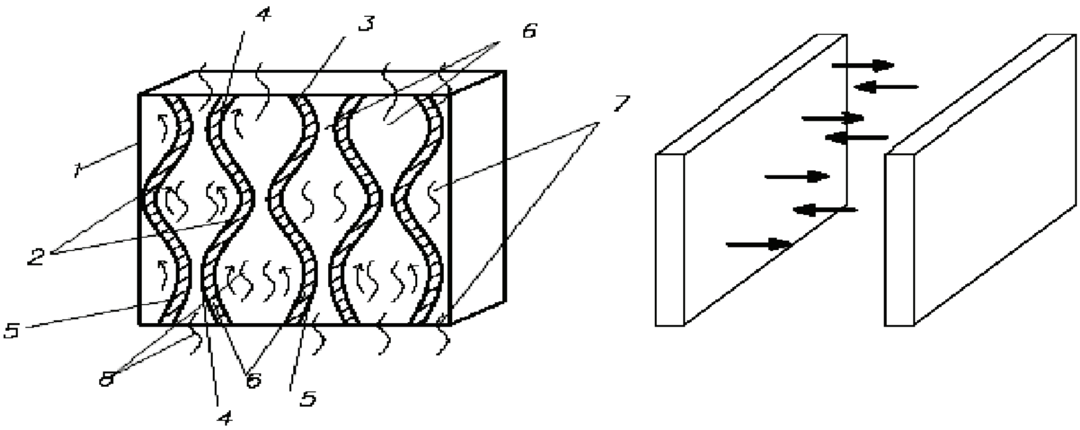

Fig. 1. Reflective baffles

References

[1] Delyagin, G., Lebedev, V., Permyakov, B. Heat-generating installation (1986) Moscow. Stroyizdat, pp. 560.
[2] Yezhov, V. Capillary cooling unit (1997) RF patent number 2095697, Mkl4 F 24 F 3/14, BIPM No31.
[3] Yezhov, V. Multicooling devices (2001) RF patent number 2168136, Mkl.4F 28 D 15/02, BIPM No 4.
[4] Yezhov, V. Device for recycling low-grade heat of the liquid (2001) RF patent number 2161765, Mkl.4 F28D9 / 00, F24F3 / 14.
[5] Yezhov, V. Capillary steam. (2002) RF patent number 2178123, Mkl.4 F 24 F 3/14, BIPM No 1.
[6] Yezhov, V. Device for utilization of low-grade heat in the high-rise buildings (2003) RF patent number 2200908, ul. 4 F 24 F 3/14, f 03 FG 7/09, BIPM No 8.
[7] Yezhov, V. Capillary water cooler (2004) Patent number 2227252, ul. F 24 F3 / 14, BIPM No11.
[8] Yezhov, V. Solar energy complex (2003) RF patent number 2213912, ul. F 24 I 2/04, 2/28, BIPM No 28.
[9] Melvin Hughes, E. Physical chemistry (1962) ch.11, Moscow, Foreign lit-ra, p. 810.
[10] Lykov, A. Heat and Mass Transfer (1978) Handbook, Moscow, Energia, p. 480.
[11] Kutepov, A. et al. Hydrodynamics and heat transfer for vaporization (1977) Moscow, Executive school, p. 352.
[12] Altschul, A., Kiselev, P. Hydraulics and aerodynamics (1975) Moscow, Stroyizdat, p. 328.
[13] Planovsky, A., Nikolaev, P. Processes and devices of chemical and petrochemical technology (1972) Moscow, Chemistry, p. 496.

[14] Gorshkov, A., Zadvinskaya, T. Comprehensive method of energy efficiency of residential house Advanced Materials Research (2014) pp. 1570-1577.
[15] Altschul, A., Givotovsky, L., Ivanov, L. Hydrodynamics and Aerodynamics (1987), Moscow, Stroyizdat, 1987, p. 415.
[16] Kaklauskas, A., Rute, J., Zavadskas, E., Daniunas, A., Pruskus, V., Bivainis, J., Gudauskas, R., Plakys, V, Passive House model for quantitative and qualitative analyses and its intelligent system , Energy and Buildings (2012) pp. 7-18.
[17] Vatin, N., Nemova, D., Staritcyna, A., Tarasova, D. Increase of energy efficiency for educational institution building (2014) Advanced Materials Research, 953-954, pp. 854-870.
[18] Vatin N., D., Nemova, D., Khazieva L., Chernik D. Distant learning course “Energy efficient refurbishment management” (2014) Applied Mechanics and Materials, 635-637, pp. 20572062.
[19] Shepelev, I. Aerodynamics of air streams in the room (1978) Moscow, Stroyizdat, p. 145.
[20] Gorelov, A., The use of glass pipes air heaters oil-fired boilers (1964) Energy. № 4. pp. 15-16.