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Results of educational building's inspection

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ABSTRACT

The article presents results of energy inspection of educational building "Gidrocorpus-2" of Saint-Petersburg State Polytechnical University. The energy audit was realized for estimation of use efficiency of energy resources and determination of opportunities for its increase. According to the results of energy audit the analyses of state of energy consumption are provided. The class of energy efficiency is defined. The recommendations and possible opportunities of energy saving and increase of power efficiency of "Gidrokorpus-2" is presented in conclusion of article.

Contents

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1. Introduction

One of the promising areas of resource saving is to reduce energy costs in the design and operation of buildings. If earlier it was decisive implementation of technical solutions which reduce the cost of construction, as a result this led to an increase in costs of heat and electricity. Now with the re-interpretation of the old principles of design in the direction of energy management has developed measures and technologies to reduce energy consumption and increase the efficiency of resource use. Now the term «energy efficiency» is treated as rational use of energy resources, however sense and the importance of this definition was beyond recommendatory measures and began to be the requirement. Confirmation to that is introduction in action of the Federal law of the Russian Federation of November 23, 2009 N 261-FZ "About energy saving and about increase of power efficiency and about modification of separate acts of the Russian Federation" [23] the international standard in the field of ISO 50001 energomendzhment, and also the developed draft of the state standard specification P 50001 standard "Systems of power management. Requirements and application guide" [27].

Thus, in the construction industry of Russia it is necessary to set the priority direction effective use of the fuel and energy resources (FER) and the made energy, having changed a classical abutment of accumulation of volumes of their extraction and production which manages much more expensively, than introduction of actions for its savings. The important reason of squandering of TER is inefficient, and sometimes even irrational consumption of energy in the sphere of housing and communal services, in the construction sphere and in the sphere of the industry [20-21].

The special role of development of increase energy efficiency belongs to designers. The main designer's objectives are to improve quality of architectural planning and construction solution [12]. The actions directed on reduction of heat losses and increases the level of thermal insulation of the building envelope require an integrated method of attack and serious research.

The main task of energy saving is opportunities to reduce energy consumption without damage the consumer and the environment. International systems of estimation ecological efficiency of buildings develop standards of quality in the modern construction industry. The standards are established for the organization of the most suitable building for the environment, it monitor the effective use of energy and water, reducing emissions of carbon dioxide, providing the most acceptable indoor climate for the creation of well-being and comfort for people.

The goal of energy inspection of “Gidrocorpus-2” is a search of possible solutions of energy saving and increase of power efficiency of the object. For scientific research of object of investigation one required:

- to conduct thermal sensing
- to fulfill thermotechnical calculations
- to draw up energy performance of the object
- to identify class of energy efficiency of the object
- to develop measures to improve class of energy efficiency of the object.

2. The overview

The solution of a question on increase of energy efficiency was considered by the scientists: Gorshkov A.S., Gagarin V. G., Trutnev M. S., Butovsky I.N. Efimenko M. N., Tabunshchikov Yu. A. Boguslavsky L.D. Monastyrev P. V., Klychnikov R. Yu. and many others [32].

Gorshkov A. S develops the schedule of dependence of thermal losses through 1 sq.m of a protecting design from the specified resistance to a heat transfer, from where it is visible that change is shown in hyperbolic dependence, however notes possibility of economically inefficient capital expenditure for construction of designs for decrease in expenses on heating. The author cites the schedule to determine the optimum thickness of the wall structure by the method of reduced costs. He produces the diagram to determine the optimum thickness of the walls of aerated concrete with different useful life [16].

Semenova E. E, Kotova K. S. considered the main architectural and technical measures to increase the energy efficiency of building and structure, the influence of the space-planning decision on the preservation of heat of the room, methods of passive use of the sun and power consumption depending on the operation of the building on the parties of light [1].

Jezierski V. A., Monastyrev P. V., Klychnikov R. Y [2] in works have defined deadline of service life of the building in which thermo modernization will break-even. According to their model to evaluate efficiency in the power protection of a particular building can be compared to their payback period (years) qualified by discounting the income from the remaining service life (in years) from the date of the heat-protective measures. Equality before the name of the variables implies that activities thermo least pay off.

Samarin O. D., using techniques developed by experts, members of the NP "AVOK" examined the effectiveness of investments in energy efficiency [3].In his works he determined the impact of climate change on the payback of additional warming of non-transparent enclosures and found that the observed trend to warming of climate gives additional arguments to the ungrounded increase of thermal insulation properties of enclosing structure.

Butovsky I. N. on the basis of the formulas known from normative documents on a heat-shielding of buildings [4] counts data on temperature and heat exchange characteristics of the air environment interacting with external protections that means on heat technical indicators of elements of a protecting cover of the building possibility of use of methodology of an assessment of energy efficiency of heated buildings by further considerations and calculations.

According to Kornienko S. V. temperature and humidity conditions in the marginal zones of enclosure has a significant impact on the energy consumption of the building. Therefore, the design must take into account the real impact is [17].

The most consistent and reasonable approach was developed by V. Gagarin, who proposed to improve mathematical model of the payback of cost on level rise thermal protection that takes into account discounting savings of operating cost. According to his model, the most important parameter in determining the economic conditions of increase the thermal security enclosure in the country or region is the limit for the one-time costs [5].

3. The initial data for calculating heat and power parameters of the building

3.1 The general descriptions of the building

The State Higher Education Institution is located at St. Petersburg, Polytechnicheskaya st, 29 (figure 1).

Figure 1. Gidrocorpus-2

The general characteristics that necessary for further calculation are:

- the overall height of the building - 24,8 m;
- the heated area - 11180.79 m^2;
- the heated volume - 43,605.08 m^3;
- the total area of the exterior walls - 14,155.57 m^2.

The composition of enclosure structure influence on heat loses essentially. Therefore it is necessary to identify the building's materials. The exterior walls of object consist of:

- gypsum plaster 5 mm;
- ceramic solid brick 510-640 mm;

- cement and sand grout 20 mm;
- stoneware tile 10 mm.

The components of roof are:

- reinforced concrete slab 180 mm;
- foamed concrete, specific gravity of 500 125 mm;
- cement-sand screed 20 mm;
- black sheeting felt 200 mm.

It has been got the information about the construction of windows. The windows of “Gidrocorpus-2” made of triple-pane glass in the metal sash, metal and wooden frame. This information was taken from the old original drawings.

The general data of building services systems has been identified. The heat supply source is the municipal network. The coolant of heating system is water with the parameters of 90 - 70 º C. HSS is located in the basement of the building. Heating system represents two-pipe vertical system with the lower adherence to the transit pipelines. The heaters represent tube-type radiators. The stop valves (ball valve on the return) and control valves are installed on the all heating appliances. There is mechanical ventilation.

3.2 Climatic and power characteristics

Design temperature of outdoor air during the cold period text is equals - 26 ºC.

The duration of the heating period is equals 220 days.

Mean temperature of outdoor air of the heating period t_{avext} is equals - 1, 8 ºC.

Heating degree day D_d is equals 5016 º C•day.

Required heat transmission resistance exterior structure:

- for the exterior walls - R_w = 3,08 (m^2 • º C) / W;
- for coverings - R_c = 4,6 (m^2 • º C) / W;
- for windows - R_F = 0,51 (m^2 • º C) / watt.

After thermal camera inspection it was found out that there were some problematic spots in the buildings envelope. The most problematic spots were the cracks between windows and walls. The spent shooting by thermal imagery device has revealed defects of windows, doors and external envelops. The thermal image reveals the main spots where there are most heat losses. The heat losses are caused by leakage of air through the gap that is between the window and the installation frame. This thermal camera inspection shows that there is a clear gap between the door frame and the wall. Therefore there is a massive leakage of indoor heat. Because of the non-functioning ventilation system users of the building often open the windows or just the smaller ventilation windows in order to refresh the indoor air (natural ventilation). When the windows are open there is a lot of leakage of heated indoor air (heat loss) (figure 2).

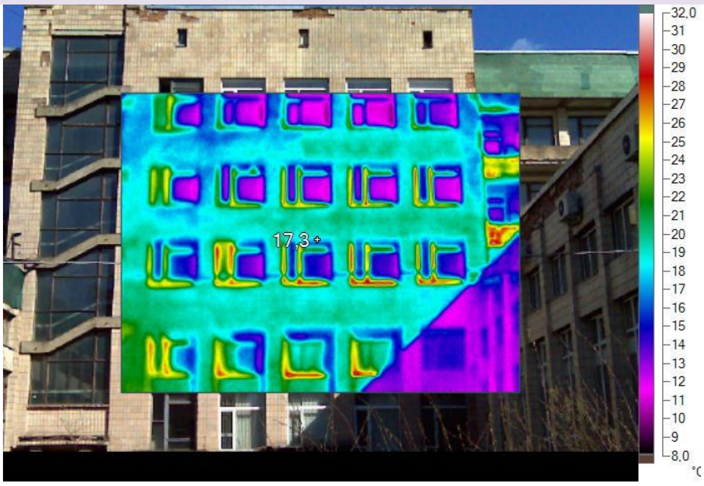

Figure 2. Thermovision photography of "Gidrokorpus 2"

4. Thermotechnical calculation

4.1 Calculated (design) value of heat transmission resistance of external envelops

It has been calculated (design) value of heat transmission resistance of external envelop. The results show that the actual values of the building (values on the left) are a lot lower than the national norms (values on the right). This means that the buildings structure causes a lot of heat losses.

External walls $R_w = 0{,}8\ (m^2 \cdot {}^oC)/W < 3{,}08\ (m^2 \cdot {}^oC)/W$
Coverage $R_c = 0{,}88\ (m^2 \cdot {}^oC)/W < 4{,}6\ (m^2 \cdot {}^oC)/W$
Windows $R_F = 0{,}3\ (m^2 \cdot {}^oC)/W < 0{,}51\ (m^2 \cdot {}^oC)/W$
Doors $R_{ed} = 0{,}26\ (m^2 \cdot {}^oC)/W < 0{,}79\ (m^2 \cdot {}^oC)/W$

Reduced transmission factor of heat transmission:

$$K_m^{tr} = \frac{\left(\frac{A_w}{R_w^r} + \frac{A_F}{R_F^r} + \frac{A_{ed}}{R_{ed}^r} + \frac{A_c}{R_c^r} + n \cdot \frac{A_{c1}}{R_{c1}^r} + n \cdot \frac{A_f}{R_f^r} + \frac{A_{f1}}{R_{f1}^r}\right)}{A_e^{sum}} =$$

$$= \frac{\left(\frac{6680{,}37}{0{,}8} + \frac{3113{,}51}{0{,}3} + \frac{50{,}7}{0{,}26} + \frac{4191{,}85}{0{,}88}\right)}{14155{,}57} = 1{,}67$$

n - rate, depend on location external of cavity of external envelop to the external air;

$A_w, A_F, A_{ed}, A_c, A_f$ - area of walls, windows, external doors and gates, coverage (garret floors), socular floors (or platforms on soil);

$R_w, R_F, R_{ed}, R_c, R_f$ - reduced of heat transmission resistance of existent external envelops.

Reduced conventional (infiltration) factor of heat transmission of building:

- On design (mechanical ventilation):

$$K_m^{inf} = \frac{0{,}28 \cdot c \cdot n_\alpha \cdot \beta_v \cdot V_h \cdot \rho_\alpha^{ht}}{A_e^{sum}} = \frac{0{,}28 \cdot 1 \cdot 0{,}92 \cdot 0{,}85 \cdot 43605{,}08 \cdot 1{,}3}{14155{,}57} = 0{,}62$$

- If mechanical ventilation doesn't work:

$$K_m^{inf} = \frac{0{,}28 \cdot c \cdot n_\alpha \cdot \beta_v \cdot V_h \cdot \rho_\alpha^{ht}}{A_e^{sum}} = \frac{0{,}28 \cdot 1 \cdot 0{,}92 \cdot 0{,}27 \cdot 43605{,}08 \cdot 1{,}3}{14155{,}57} = 0{,}18$$

c - elastivity heat storage capacity equals to 1 kJ/(kg·ºC);

n_{α} – average repetition factor of air change for heat season, h[1], for buildings social services calculate on total air change funded with ventilation and infiltration;

β_v - factor, inclusive part internal external envelops in heating volume of building, equal to 0,85;

V_h – heating volume of building, m^3;

ρ_{α}^{ht} – average density external air for heat season, kg/m^3.

Total factor of heat transmission, Km, W/(m^2·ºC):

$$K_m = K_m^{tr} + K_m^{inf} = 1,67 + 0,18 = 1,85.$$

5. Relating to spatial planning characteristics of buildings

Coefficient of glazing a building coefficient determine as:

$$f = \frac{A_F}{A_{w+F+ed}} = \frac{3113,51}{10768,37} = 0,29.$$

Coefficient of compactability of the building determine as:

$$k_e^{des} = \frac{A_e^{sum}}{V_h} = \frac{14155,57}{43605,08} = 0,32$$

6. Calculation of heat and energy datum of buildings

Total heat losses of the building through external envelop inclusive of ventilation:

$$Q_h = 0,0864 \cdot K_m \cdot D_d \cdot A_e^{sum} = 0,0864 \cdot 1,67 \cdot 5016 \cdot 14155,57 = 10245074 \ (MJ)$$

Genre heat gain:

$$Q_{int} = 0,0864 \cdot q_{int} \cdot z_{ht} \cdot A_{\ell} = 0,0864 \cdot 10 \cdot 220 \cdot 7793,6 = 1481407 \ (MJ)$$

Heat gain through windows and glasses from sun radiation:

$$Q_s = \tau_F \cdot k_F \cdot (A_{F1} \cdot I_1 + A_{F2} \cdot I_2 + A_{F3} \cdot I_3 + A_{F4} \cdot I_4) + \tau_{scy} \cdot k_{scy} \cdot A_{scy} \cdot I_{hor} =$$
$$= 0,78 \cdot 0,76 \cdot (1228,1 \cdot 455 + 210,09 \cdot 455 + 787,96 \cdot 902) = 809241 \ (MJ),$$

0, 0864 – conversion factor (1 day = 24 h; 1 Вт =1/1000 kW; 1 Вт•ч =3,6 kJ).

The amount used of energy on heating of buildings during heating season:

$$Q_h^y = \left[Q_h - (Q_{int} + Q_s) \cdot \nu \cdot \xi\right] \cdot \beta_h = \left[102450074 - (1481407 + 809241) \cdot 0,8 \cdot 0,95\right] \cdot 1,11 = 111787191 \ (MJ),$$

ν – coefficient of lowering heat gain at the expense of heat inertia external envelops; recommended value ν = 0,8;

ξ – coefficient of efficiency auto regulation heat supply in heater system (in double-pipe scheme with thermostats and with central auto regulation on bus ξ = 0,95);

β_h - coefficient , inclusive coefficient additional heat consumption of heater system , bond discontinuity of nominee heat flow of nomenclative range of heating apparatus, their additional heat losses through parts of external envelops, higher air temperature in rooms, heat losses of pipes, get through unheated rooms, equal to β_h =1,11.

Calculate specific drain of energy on heating of building:

$$q_h^{des} = \frac{10^3 \cdot Q_h^y}{V_h \cdot D_d} = \frac{10^3 \cdot 111787191}{43605{,}08 \cdot 5016} = 86\left(kJ/(m^3 \cdot {}^oC \cdot day)\right).$$

For social services it is equal to= 27 кJ/ ($m^3 \cdot {}^oC \cdot$day).

The external envelops of 5-store building social educational services do not meet standard requirements. Value of defection calculates specific drain of energy on heating of building from standard requirements is -9%. So, it is a building of E class («Very low») on energy efficiency.

The necessary measures to solve the problems of the buildings:

1. Modernization and automatization of ventilation system , heater system;
2. Exchange of window to plastic double-glazed windows;
3. Rise of thermal properties of external envelops.

Today building green is becoming more and more important as our resources run out, and it becomes more aware of the sensitivities to toxins that many people have. With the price of oil and natural gas rising, saving energy is a big concern. The use of green construction in home and business developments has started really taking off, and many people are interested in making their developments environmentally friendly. It would be possible to increase energy efficiency of “Gidrocorpus-2” to LEED standards with all required parameters using environmentally friendly insulation materials [7], and renewable energy sources which will ensure the safety and favorable conditions of healthy human life, as well as limiting the negative impact on the environment.

7. Resume

In this article it has been described and analyzed the results of energy audit of 5-store building social educational services “Gidrocorpus-2”, performed termotechnical calculation, defined a class of energy efficiency, proposed possible ways to improve class of energy efficiency of the object.

If we compare the values obtained with the normative values for determining the energy efficiency class of the building adopted by the Ministry of Regional Development of the Russian Federation, we can see that the building Gydrophysics-2 in many respects doesn’t meet the standards. Thus, value calculate specific drain of energy on heating of building from standard requirements is - 9%. So, it is a building of E class («Very low») on energy efficiency. Thus the building did not meet the required standards. The results of the inspection and analysis need for further research. One of possible solution of the problem is the reconstruction of the building in accordance with the American rating system LEED, using environmentally friendly measures [7], which will ensure the safety and favorable conditions of healthy human life, as well as limiting the negative impact on the environment.

References

1. Semenova E.E, Kotova K.S. Razrabotka mer po povyisheniyu energeticheskoy effektivnosti zdaniy // Nauchnyiy Vestnik Voronezhskogo gosudarstvennogo universiteta arhitekturyi i stroitelstva. Vyisokie tehnologii. Ekologiya. 2012. №1. S. 193-196 .
2. Ezerskiy V.A., Monastyirev P.V., Klyichnikov R.Yu. Vliyanie parametrov teploizolyatsii elementov zhilogo doma na rashod teplovoy energii // Academia. Arhitektura i stroitelstvo. 2009. № 5. S. 291-296.
3. Samarin N.D. Vliyanie energosberegayuschih meropriyatiy na energeticheskiy balans zdaniy // Energosberezhenie i vodopodgotovka . 2007. №3. S. 68-70.
4. Butovskiy I.N. Osobennosti teplotehnicheskogo rascheta teplozaschityi i energopotrebleniya sovremennyih zhilyih i obschestvennyih zdaniy pri otsenke ih energoeffektivnosti. // Akademiya. Arhitektura i stroitelstvo. 2009. S. 356-361.
5. Gagarin V.G. Teplofizicheskie problemyi sovremennyih stenovyih ograzhdayuschih konstruktsiy mnogoetazhnyih zdaniy. // Akademiya. Arhitektura i stroitelstvo. 2009. №5. S. 297-305.
6. Gagarin V.G., Kozlov V.V. O normirovanii teplopoter cherez obolochku zdaniya // Akademiya. Arhitektura i stroitelstvo. 2010. № 3. S. 279-286.
7. Bobrov Yu.L., Ovcharenko E.G. Teploizolyatsionnyie materialyi i konstruktsii // Uchebnik dlya srednih professionalno-tehnicheskih uchebnyih zavedeniy. M.: INFRA-M, 2003. C.268.

8. Tabunschikov Yu. A. «Zelenyie» zdaniya v Rossii // AVOK: Ventilyatsiya, otoplenie, konditsionirovanie vozduha, teplosnabzhenie i stroitelnaya teplofizika. 2010. №5. S. 14-15.
9. Livchak V.I, Matrosov Yu.A. Ryichagi povyisheniya energoeffektivnosti zdaniy // AVOK: Ventilyatsiya, otoplenie, konditsionirovanie vozduha, teplosnabzhenie i stroitelnaya teplofizika. 2008. №8. S. 10-16.
10. Matrosov Yu.A. Energoeffektivnost i ekologiya – osnova sovremennyih trebovaniy k teplozaschite zdaniy // Academia. Arhitektura i stroitelstvo. 2009. №5. S. 283-290.
11. Severova E.A., Pashkevich S.A., Adamtsevich A.O. Energeticheskaya effektivnost stroitelnoy otrasli v Rossii – aspektyi razvitiya // Stroitelstvo unikalnyih zdaniy i sooruzheniy. 2013.№ 1. S. 18-21.
12. Gorshkov A.S. Energoeffektivnost v stroitelstve: voprosyi normirovaniya i meryi po snizheniyu energopotrebleniya zdaniy. // Inzhenerno-stroitelnyiy zhurnal. 2010. № 1(11). S. 9-13.
13. Savin V.K. Novyie podhodyi k otsenke energosberezheniya i energeticheskoy effektivnosti v stroitelnoy otrasli // Stroitelnyie nauki. 2010. S. 210-245.
14. 1Galyuzhin S.D, Galyuzhin A.S, Lyubikova O.M. Ohrana truda. Ohrana okruzhayuschey sredyi. Geoekologiya/ / Vestnik Belorussko-Rossiyskogo universiteta. 2007. №2(15). S.84-94.
15. 1Rasporyazhenie ministerstva prirodnyih resursov i ekologii rossiyskoy federatsii ot 30 dekabrya 2009 g. № 75-r «o dobrovolnoy ekologicheskoy sertifikatsii ob'ektov nedvizhimosti s uchetom mezhdunarodnogo opyita primeneniya "zelenyih" standartov»
16. Gorshkov A.S., Gladkih A.A. Meropriyatiya po povyisheniyu energoeffektivnosti v stroitelstve // Academia. Arhitektura i stroitelstvo. 2010.№ 3. S. 246-250.
17. Kornienko S.V. Otsenka vliyaniya kraevyih zon ograzhdayuschih konstruktsiy na teplozaschitu i energoeffektivnost zdaniy. // Inzhenerno-stroitelnyiy zhurnal. 2011. №8. C. 5-12.
18. Nemova D.V. Analiz tselesoobraznosti uvelicheniya tolschinyi teploizoliruyuschego sloya v sistemah navesnyih ventiliruemyih fasadov (NVF) v tselyah povyisheniya energoeffektivnosti // Vestnik Moskovskogo gosudarstvennogo stroitelnogo universiteta. 2011. № 7. S. 98-103.
19. Tabunschikov Yu.A. Litsom k probleme energosberezheniya // Arhitektura i stroitelstvo Moskvyi. 2010. T. 554. № 6. S. 2-13.
20. Gorshkov A.S., Gladkih A.A. Meropriyatiya po povyisheniyu energoeffektivnosti v stroitelstve // Academia. Arhitektura i stroitelstvo. 2010. № 3. S. 246-250.
21. Gorshkov A. S. Energoeffektivnost v stroitelstve: voprosyi normirovaniya i meryi po snizheniyu energopotrebleniya zdaniy // Inzhenerno-stroitelnyiy zhurnal. 2010. № 1. S. 9-13.
22. Federalnyiy zakon № 261-FZ «Ob energosberezhenii i o povyishenii energeticheskoy effektivnosti i o vnesenii izmeneniy v otdelnyie zakonodatelnyie aktyi Rossiyskoy Federatsii».
23. GOST R 52106-2003. Resursosberezhenie. Obschie polozheniya.
24. SP 23-101-2004. Proektirovanie teplovoy zaschityi zdaniy.
25. Vatin N.I., Nemova D.V. Povyishenie energoeffektivnosti zdaniy detskih sadov // Stroitelstvo unikalnyih zdaniy i sooruzheniy. 2012. №3. S. 52-76.
26. Tseytin D.N., Nemova D.V., Kurasova E.V. Avtonomnaya energoustanovka s kompleksnyim energoeffektivnyim elektroobespecheniem. // Stroitelstvo unikalnyih zdaniy i sooruzheniy. 2013. №5. S. 1-11.
27. Tseytin D.N., Nemova D.V., Kurasova E.V. Autonomous power installation with complex power effective electroproviding // Construction of Unique Buildings and Structures. 2013. №5. S. 1-11.
28. Guillermo Escriva-Escriva. Basic actions to improve energy efficiency in commercial buildings in operation // Energy and Buildings. 2011. №43. S. 3106-3111.
29. Josifas Parasonis, Andrius Keizikas. Increasing Energy Efficiency of the Translucent Enclosure Walls of a Building. // Procedia Engineering. 2013. № 57. S. 869-875
30. Ambrose Dodoo, Leif Gustavsson, Roger Sathre. Building energy-efficiency standards in a life cycle primary energy perspective. // Energy and Buildings. 2011. №43. S. 1589-1597
31. Daniela Popescu, Sven Bienert, Christian Schützenhofer, Rodica Boazu. Impact of energy efficiency measures on the economic value of buildings // Applied Energy. 2012. №89. C. 454-463.
32. *Rekonstrukcija krysh Sankt-Peterburga na osnove legkih stal'nyh tonkostennyh konstrukcij i antiobledenitel'noj sistemy* / Petrov K.V., Zolotareva E.A., Volodin V.V., Vatin N.I., Zhmarin E.N. // Magazine of Civil Engineering. 2010. No. 2. Pp. 59-64. (rus)

Литература

1. Семенова Е.Е, Котова К.С. Разработка мер по повышению энергетической эффективности зданий // Научный Вестник Воронежского государственного университета архитектуры и строительства. Высокие технологии. Экология. 2012. №1. С. 193-196 .
2. Езерский В.А., Монастырев П.В., Клычников Р.Ю. Влияние параметров теплоизоляции элементов жилого дома на расход тепловой энергии // Academia. Архитектура и строительство. 2009. № 5. С. 291-296.
3. Самарин Н.Д. Влияние энергосберегающих мероприятий на энергетический баланс зданий // Энергосбережение и водоподготовка . 2007. №3. С. 68-70.
4. Бутовский И.Н. Особенности теплотехнического расчета теплозащиты и энергопотребления современных жилых и общественных зданий при оценке их энергоэффективности. // Академия. Архитектура и строительство. 2009. С. 356-361.
5. Гагарин В.Г. Теплофизические проблемы современных стеновых ограждающих конструкций многоэтажных зданий. // Академия. Архитектура и строительство. 2009. №5. С. 297-305.
6. Гагарин В.Г., Козлов В.В. О нормировании теплопотерь через оболочку здания//Академия. Архитектура и строительство. 2010. № 3. С. 279-286.
7. Бобров Ю.Л., Овчаренко Е.Г. Теплоизоляционные материалы и конструкции // Учебник для средних профессионально-технических учебных заведений. М.: ИНФРА-М, 2003. С.268.
8. Табунщиков Ю. А. «Зеленые» здания в России // АВОК: Вентиляция, отопление, кондиционирование воздуха, теплоснабжение и строительная теплофизика. 2010. № 5. С. 14-15.
9. Ливчак В.И, Матросов Ю.А. Рычаги повышения энергоэффективности зданий // АВОК: Вентиляция, отопление, кондиционирование воздуха, теплоснабжение и строительная теплофизика. 2008. №8. С. 10-16.
10. Матросов Ю.А. Энергоэффективность и экология – основа современных требований к теплозащите зданий // Academia. Архитектура и строительство. 2009. № 5. С. 283-290.
11. Северова Е.А., Пашкевич С.А., Адамцевич А.О. Энергетическая эффективность строительной отрасли в России – аспекты развития // Строительство уникальных зданий и сооружений. 2013. № 1. С. 18-21.
12. Горшков А.С. Энергоэффективность в строительстве: вопросы нормирования и меры по снижению энергопотребления зданий. // Инженерно-строительный журнал. 2010. № 1(11). С. 9-13.
13. Савин В.К. Новые подходы к оценке энергосбережения и энергетической эффективности в строительной отрасли // Строительные науки. 2010. С. 210-245.
14. Галюжин С.Д, Галюжин А.С, Любикова О.М. Охрана труда. Охрана окружающей среды. Геоэкология/ / Вестник Белорусско-Российского университета. 2007. №2(15). С.84-94.
15. Распоряжение министерства природных ресурсов и экологии российской федерации от 30 декабря 2009 г. № 75-р «о добровольной экологической сертификации объектов недвижимости с учетом международного опыта применения "зеленых" стандартов»
16. Горшков А.С., Гладких А.А. Мероприятия по повышению энергоэффективности в строительстве // Academia. Архитектура и строительство. 2010.№ 3. С. 246-250.
17. Корниенко С.В. Оценка влияния краевых зон ограждающих конструкций на теплозащиту и энергоэффективность зданий. // Инженерно-строительный журнал. 2011. №8. С. 5-12.
18. Немова Д.В. Анализ целесообразности увеличения толщины теплоизолирующего слоя в системах навесных вентилируемых фасадов (НВФ) в целях повышения энергоэффективности // Вестник Московского государственного строительного университета. 2011. № 7. С. 98-103.
19. Табунщиков Ю.А. Лицом к проблеме энергосбережения // Архитектура и строительство Москвы. 2010. Т. 554. № 6. С. 2-13.
20. Горшков А.С., Гладких А.А. Мероприятия по повышению энергоэффективности в строительстве // Academia. Архитектура и строительство. 2010. № 3. С. 246-250.
21. Горшков А. С. Энергоэффективность в строительстве: вопросы нормирования и меры по снижению энергопотребления зданий // Инженерно-строительный журнал. 2010. № 1. С. 9-13.
22. Федеральный закон № 261-ФЗ «Об энергосбережении и о повышении энергетической эффективности и о внесении изменений в отдельные законодательные акты Российской Федерации».
23. ГОСТ Р 52106-2003. Ресурсосбережение. Общие положения.

24. СП 23-101-2004. Проектирование тепловой защиты зданий.
25. Ватин Н.И., Немова Д.В. Повышение энергоэффективности зданий детских садов // Строительство уникальных зданий и сооружений. 2012. №3. С. 52-76.
26. Цейтин Д.Н., Немова Д.В., Курасова Е.В. Автономная энергоустановка с комплексным энергоэффективным электрообеспечением. // Строительство уникальных зданий и сооружений. 2013. №5. С. 1-11.
27. Tseytin D.N., Nemova D.V., Kurasova E.V. Autonomous power installation with complex power effective electroproviding. // Construction of Unique Buildings and Structures. 2013. №5. С. 1-11.
28. Guillermo Escriva-Escriva. Basic actions to improve energy efficiency in commercial buildings in operation // Energy and Buildings. 2011. №43. С. 3106-3111.
29. Josifas Parasonis, Andrius Keizikas. Increasing Energy Efficiency of the Translucent Enclosure Walls of a Building. // Procedia Engineering. 2013. № 57. С. 869-875
30. Ambrose Dodoo, Leif Gustavsson, Roger Sathre. Building energy-efficiency standards in a life cycle primary energy perspective. // Energy and Buildings. 2011. №43. С. 1589-1597
31. Daniela Popescu, Sven Bienert, Christian Schützenhofer, Rodica Boazu. Impact of energy efficiency measures on the economic value of buildings // Applied Energy. 2012. №89. С. 454-463
32. Реконструкция крыш Санкт-Петербурга на основе легких стальных тонкостенных конструкций и антиобледенительной системы / Петров К.В., Золотарева Е.А., Володин В.В., Ватин Н.И., Жмарин Е.Н. // Инженерно-строительный журнал. 2010. № 2. С. 59-64.

Результаты обследования образовательного учреждения

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АННОТАЦИЯ

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