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STUDY OF HEATING SYSTEMS WITH RENEWABLE SOURCES BASED ON THE PROJECT «CONTROL ROOM IN THE CITY OF BALKASH»

Abstract. *Recently, the rational use of energy resources has become one of the key problems of the specialty. Today, its solutions, as a rule, are aimed at improving the thermal protection of enclosing structures and the efficiency of heat supply. However, the key issues in the efficient use of energy are the problems of consuming systems - heating, ventilation and air conditioning. In this article, the authors conduct a study of heating systems with renewable sources based on a finished project that will help reduce the consumption of energy resources.*

Keywords: *energy resources, renewable sources, solar system, building codes, building regulations, heating systems, heat losses, energy efficiency.*

Introduction

Energy consumption around the world is constantly growing. The lion's share of all thermal energy generated in the world is used to ensure the operation of engineering systems and networks of buildings and various construction projects. It is known that one third of all energy on the planet is used to provide heat to civil and administrative buildings. In recent years, the use of solid combustible fuels has been reduced in thermal power engineering, and instead of it, a more economically and environmentally efficient type of fuel, gas, is widely used. Due to the constant rise in the price of all types of fuel, the transition to economically profitable types of fuel and the reduction of its consumption, as well as the transition to more energy efficient methods, is an urgent problem today.

Most of the heat used for municipal and residential needs goes to heating systems. This is due to the need to fill the heat losses of buildings and premises during the cold season. Heating systems are needed in order to provide a comfortable temperature during the cold season.

Today, modern buildings are built from lightweight, but at the same time durable structures. Such structures are additionally sheathed with effective and modern types of thermal insulation. This allows you to significantly reduce the estimated load on heating. New technologies and equipment are also widely used in the design of heating and ventilation systems for new buildings.

Based on current statistics, it can be seen that in Kazakhstan, fuel is still in demand (Figure 1).

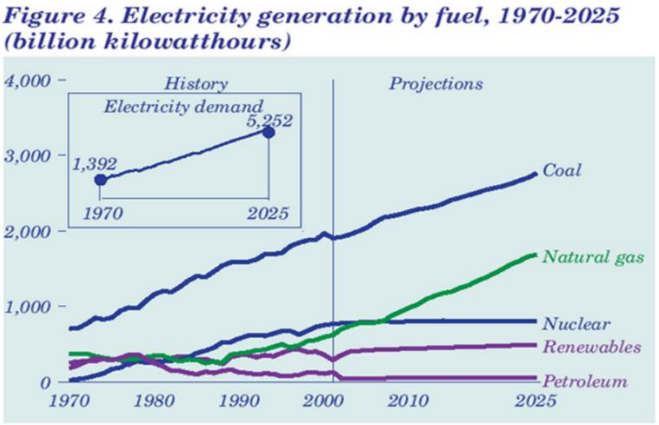

Figure 1 – Electricity Generation by Fuel [Resource: Annual Energy Outlook 2005]
(Figure 5 on page 6)

Of course, this statistic is disappointing. By consuming more and more fuel, mankind is not only gradually approaching to be left without it, a precious sought-after natural material, but also pollute the air, with the release of harmful substances, which accordingly affects health.

Scientists thinking about this situation, found a solution to the problem. In fact, now it is possible to list several options for solving the problem with renewable energies, these are: geothermal systems, solar systems, and there are also recuperators, recycling. For general convenience, there are types of houses like passive, active and zero buildings.

Materials and methods

In this article, a solar system will be used as equipment. The authors will analyze how this building is designed, how much heat loss is and how much it covers, respectively, if it suddenly does not cover, options for solving this situation will be proposed.

The control room was designed in the city of Balkhash. Based on the “Construction Climatology”, the outdoor temperature of the coldest five-day period is t = -27.5ºC, the duration of the heating period is Z = 200 days a year. It can be seen that the city is quite cold. The heated construction volume of the designed building is 739.4 m3.

The project begins with a heat engineering calculation, after data collection, which in turn shows how well the building is insulated from the cold. The thermotechnical calculation is shown in the following table 1.

Table 1

	Material	Layer thickness, mm	Coefficient of thermal conductivity λ, W/(м·С)
1	Brickwork	0,38	0,4
2	Two-layer insulation	0,1	0,04

The main heat loss, as is customary, comes from windows, doors and stained-glass windows. Because of this, many architects and designers are trying to put into the project materials where the thermal performance is relatively the best. In this case, energy-efficient four-layer windows were chosen as external windows. Taking into account all these factors and characteristics, the heat losses of the building are calculated. The heat load on a building whose area is 254.67 m2 is 28836 W, the load on hot water supply is 11194 W. The total load on the building is 40030 W, i.e. 40.03 kW.

Based on the characteristics, you can select which “Building Norms” and “Building Rules” are suitable for the project:

BN RK 4.02-01-2011 "Heating, ventilation and air conditioning";

BN RK 2.04-01-2017 "Construction climatology";

BN RK 4.02-101-2012 "Heating, ventilation and air conditioning";

BR RK 3.02-108-2013 in English - Administrative and amenity buildings;

BN RK 3.02-08-2013 "Administrative and amenity buildings".

The project uses water as a heat carrier in the heating system. The temperature of the heat carrier is 80ºC in the supply pipeline and 60 ºC in the return pipeline.

Aluminum radiators Colidor Super and KVZ 0.85 type convectors were chosen as local heating devices, and pipelines laid in the floor structure are made of metal-plastic pipes from KAN. The heating system is designed as a two-pipe with a passing movement of the coolant.

Using all these data and calculations for the administrative building, based on the heat loss of each room, heating devices were selected and a piping system was carried out, based on the architectural solutions on the plan. There are 3 systems in total:

1) On the first floor;

2) To the landing (a separate branch of the pipeline);

3) To the second floor:

The project will use a solar system. Why was the solar system chosen?

A solar system is a device for converting the energy of solar radiation into other forms of energy that are convenient for use. In fact, this device saves many (those people who live far outside the city. Of course, it has a number of advantages:

• Saving the lion's share of energy;

• If calculated correctly, it can generate up to 80 percent of energy, if the house is still zero or passive, then even more;

• Payback, for 7-8 years you can recoup the funds that were laid out;

• Composition of the solar system: aluminum, glass. The list shows that wear will not be fast.

In the project, the solar system is located on the roof of the building. Sloped roof, fully laid on one side. After it was determined how much would fit on the roof, a place was found for installing expansion tanks. Stainless corrugated pipes exit the solar system and go down to the expansion tanks and they enter the storage tanks (there are 2 of them in the project), which, in turn, heats up the coolant with the help of heat exchange and a steel pipe leaves it, then it is fed to the boiler. The project has

a limited space for installing solar systems. After the heat release from the solar system was determined using the calculation, it was understood that 5 kW of heat from the required amount is not heated up. Even if we take into account the adverse weather conditions, the coolant will not heat up to the end, and then an additional heater will be needed. For this, a solution has been found that will not have adverse environmental conditions, such as the release of carbon dioxide. This is a supply electric boiler.

An electric boiler usually consists of: a heat exchanger, a block of heating elements, a control unit and control and safety devices. Perhaps some electric boilers are equipped with a circulation pump, expansion tank, safety valve and filter. The coolant heated by electricity circulates through a system of pipes and radiators, providing space heating, as well as heating water in the boiler. An electric double-circuit boiler is used for heating and hot water supply, a single-circuit boiler is used only for heating a house, as well as for underfloor heating.

Leaving the storage tank, they are brought to an electric boiler, which, in turn, sees how hot the water is from the required one, here you can control the temperature. In case of underheating, the boiler heats up to the required temperature for the heating system 80ºC and supplies it to the system. All that is laid down can be seen in the attached figure 2.

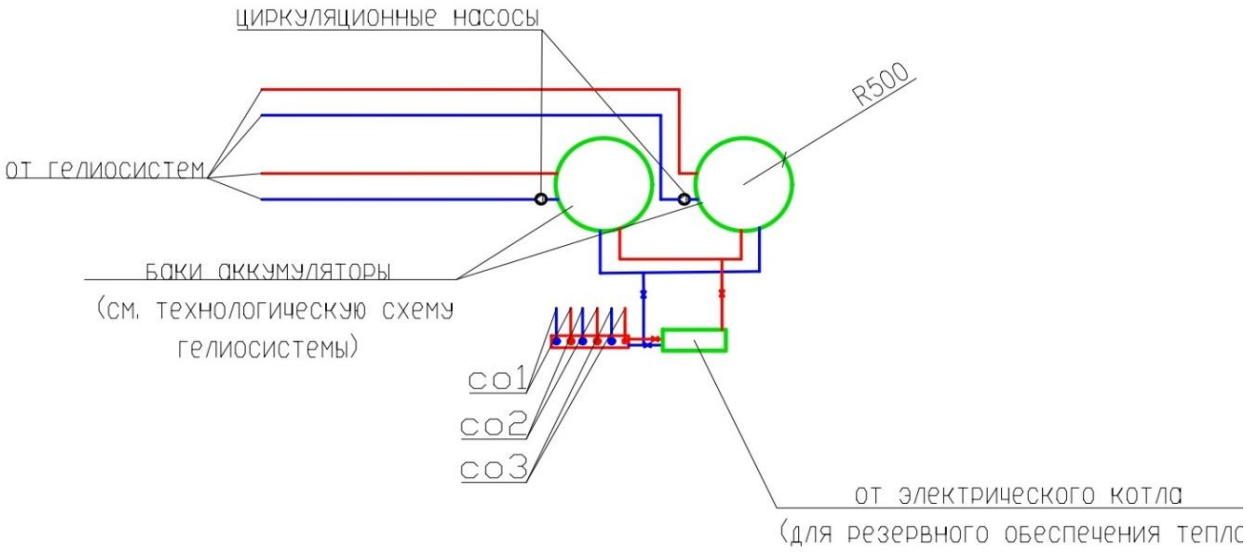

Figure 2 – Scheme of heating systems [Author's material]:
1 – циркуляционные насосы – circulation pumps; 2 – от гелиосистем – from solar systems; 3 – баки аккумуляторы – tanks accumulators; 4 – см. технологическую схему гелиосистемы – see technological scheme of the solar system; 5 – от электрического котла – from electric boiler; 6 – для резервного обеспечения тепла – for backup heat supply.

Results and discussion

ZOTA W 36 "luxe" was chosen as an electric boiler in the project (power consumption of electricity is 4.8 kW). While designing in the course of the case, it was found that the largest heat loss was on the second floor in room No. 6, in which

stained-glass windows were designed in a U-shaped form. In turn, this takes 35% of the total heat loss for the entire building. This is 10093 W from 40.03 kW. Given that the solar system does not heat up 5 kW, because of this, it was decided to install an electric boiler. If the house were made zero or passive, or if the glazing area were reduced, then, accordingly, there would be no need for an additional device. Taking into account the decisions of the architect and the client, they were such that the building was suitable for an office and, accordingly, the design part met these requirements. In this case, it can be proposed that the stained-glass windows and windows be four-layer, in which the heat loss coefficient is equal to or less than 1.2 instead of 2.5 for ordinary windows, or the second option is energy-efficient windows with a coefficient of 0.75. And also there is an option to insulate the outer walls with silicate airgel. It is a new kind of thermal insulation material which is super light, with a density of up to 143 kg/m3 and a thermal conductivity coefficient of 0.012 to 0.030 W/(mK).

Conclusions

As described above, there are passive, active and zero energy buildings. In this project, the authors tried to make the house passive. To do this, they installed solar systems, which makes it clear that energy comes from renewable sources. By comparing the options, and suggesting ideas, the authors succeeded.

References:

1. *Toropov A. L. (2019) Kombinirovannye teplovye solnechnye sistemy. CHast' 1. Teplovye solnechnye kollektory dlya individual'nyh i decentralizovannyh sistem otopleniya i goryachego vodosnabzheniya: uchebnoe posobie [Combined thermal solar systems. Part 1. Thermal solar collectors for individual and decentralized heating and hot water supply systems] - M.: Izdatel'skij dom Akademii Estestvoznaniya, 88. (in Russ.) DOI: 10.17513/np.346.*
2. *Tanaka S, Suda R (1989) Solar heating (solar systems). Residential buildings with solar heat and cold suppy. ISBN 5-274-00485-7. (in Japan)*
3. *Tanaka S., Suda R (1989) Solnechnoe otoplenie (solnechnyie sistemyi). Zhilyie zdaniya s solnechnyim teplom i holodosnabzheniem [Solar heating (solar systems). Residential buildings with solar heat and cold supply] – M.: Stroyizdat, 185.*
4. *Informaciya o solnechnyh sistemah [Information about solar systems] [Electron. Resurs.]* – URL: https://dic.academic.ru/dic.nsf/ruwiki/1371078 *(in Russ)*
5. *Informatsiya o geliosistemah [Information about solar systems] [Elektron. resurs]. - URL: https://dic.academic.ru/dic.nsf/ruwiki/1371078 (in Russ.)*
6. *Princip raboty elektricheskogo kotla [The principle of operation of an electric boiler] [Electron. resource]* – URL: http://thermomir.ru/doc/recomend/help_electro_kotly/ princip_raboty_jelektricheskogo_kotla *(in Russ.)*

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«БАЛҚАШ ҚАЛАСЫНДАҒЫ ДИСПЕТЧЕРЛІК» ЖОБАСЫ НЕГІЗІНДЕ ЖАҢАРТЫЛҒАН КӨЗДЕРІ БАР ЖЫЛУ ЖҮЙЕЛЕРІН ЗЕРТТЕУ

Аңдатпа. *Соңғы уақытта энергетикалық ресурстарды ұтымды пайдалану мамандықтың басты мәселелерінің біріне айналды. Бүгінгі таңда оның шешімдері, әдетте, қоршау құрылымдарының жылу қорғанысын және жылумен жабдықтаудың тиімділігін арттыруға бағытталған. Сонымен қатар, энергияны тиімді пайдалану ісіндегі негізгі мәселелер тұтынатын жүйелер – жылыту, желдету және ауаны баптау проблемалары болып табылады. Бұл мақалада авторлар энергия ресурстарын тұтынуды азайтуға көмектесетін дайын жоба негізінде жаңартылатын көздері бар жылу жүйелерін зерттеуді жүргізеді.*

Түйін сөздер*: энергия ресурстары, жаңартылатын көздер, күн жүйесі, құрылыс нормалары, құрылыс ережелері, жылу жүйелері, жылу жоғалтулары, энергия тиімділігі.*

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ИССЛЕДОВАНИЕ СИСТЕМ ОТОПЛЕНИЯ С ВОЗОБНОВЛЯЕМЫМИ ИСТОЧНИКАМИ НА ОСНОВЕ ПРОЕКТА «ДИСПЕЧЕРСКАЯ В ГОРОДЕ БАЛХАШ»

Аннотация. *В последнее время рациональное использование энергетических ресурсов стало одной из ключевых проблем специальности. Сегодня ее решения, как правило, направлены на повышение теплозащиты ограждающих конструкций и эффективности теплоснабжения. Вместе с тем, ключевыми вопросами в деле эффективного использования энергии являются проблемы потребляющих систем – отопления, вентиляции и кондиционирования воздуха. В этой статье авторами проводятся исследование систем отопления с возобновляемыми источниками на базе готового проекта, который поможет снизить потребление энергетических ресурсов.*

Ключевые слова: *энергоресурсы, возобновляемые источники, солнечная система, строительные нормы, строительные нормы, системы отопления, тепловые потери, энергоэффективность.*